Phase I and II Geoenvironmental Site Assessment

Site: Crabtree Lane, Manchester
Reference: 17-548-R1
Date: April 24



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QUALITY ASSURANCE

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EXECUTIVE SUMMARY

Site Address	Crabtree Lane, Manchester, M11 4GU
Grid Reference	E388825, N398057
Site Area	0.69 Ha
Proposed Development	Connell Developments Ltd intends to divest the subject site with a view to the site being redeveloped for a mixed low-rise and high-rise residential development with associated gardens/landscaping, estate roads and infrastructure.
Current Site Use	The site is an irregularly shaped parcel of land located to the east of Crabtree Lane. The Ashton Canal is present to the north of the site boundary circa 0.50 m lower in elevation. The site is generally a level plateau however, there are mounds of material and stockpiled rubble present on-site and a small area of raised slab in the north. Upon entering the site through a gate off of Crabtree Lane, access is gained via a private road to the main site, there were several skips at the site that were being used for site clearance. Connell Developments Ltd has confirmed these will be removed ahead of divestment. The site is predominantly covered in concrete or asphalt hardstanding, although there are areas of broken gravel surfacing and the aforementioned stockpiles. All the former buildings on site have been demolished and no structures are on site except a temporary shipping container acting as a site office.
Site History	An examination of the relevant Ordnance Survey maps from 1848 to the present shows that the site originally is recorded as undeveloped land. However, there is a culvert present (no indication of the culvert location can be determined from the mapping). Circa 1890 an Iron Foundry is recorded on the site. By 1906 the foundry had been extended further and by this time covered the majority of the site with a chimney also detailed in the larger scaled mapping. Circa 1932 the site's layout remains the same but it has now been relabelled Acre Works (Packaging Materials). In 1949 a refuse heap was recorded to the south of the site which appears to encroach into the southern (leasehold) sector of the site. The landfill markings remained until 1964, when it was no longer present and the Acre Works had just been labelled as an unspecified works. By 2003 site structures were demolished and the site was vacant land, and by 2019 any rough scrub vegetation that had grown since the former works demolition had been removed. In 2024, satellite imagery depicts the site being occupied by a service yard, with the loading/unloading and storage of materials.

ENVIRONMENTAL SETTING

Geology	Drift Geology	Till, Devensian – Diamicton: SAND, CLAY and GRAVEL
	Bedrock Geology	Manchester Marls Formation: MUDSTONE
Geomorphology	The site has been subject to anthropogenic change which will likely have resulted in a greater thickness of Made Ground. Upfilling and levelling works are likely to have occurred during construction and demolition to form a level plateau.	
Hydrogeology	A Secondary (undifferentiated) Aquifer has been recorded on site in the drift geology with a Secondary B Aquifer in the bedrock geology. The site is not located within a defined Source Protection Zone.	
	A groundwater abstraction licence is recorded 687 m west of the site.	
Hydrology	The nearest surface water feature is the Ashton Canal approximately 5 m north of the site. Due to the local topography, it is likely that any shallow groundwater, will follow the general fall of the land to the southwest.	
	The site is located within Flood Zone 1 - low risk of fluvial flooding.	
Utility Locations	A formal utility survey has not been completed; however, a review of service records indicates that there are no current services on-site. A culvert is recorded on historical maps but its presence has not been confirmed.	
Landfill Sites and Waste Sites	A historic landfill is recorded to the south of the site operating between 31/12/1942–31/12/1992 and receiving inert, industrial permitting regulations (waste). Another landfill is recorded 113 m west but the details about this site are unknown. The landfill appears to have encroached into the southern (leasehold) sector of the site. The site has also undergone historical development and ground working, the Made Ground associated with the landmark development may produce hazardous ground gases such as methane and carbon dioxide.	
Radon	Radon Class 1 - less than 1% of homes are estimated to be at or above the Action Level. No radon protection measures are required.	
Unexploded Ordnance	A detailed UXO risk assessment has been completed by Brimstone and is presented in Appendix XI.	
PFAS	No potential current or historical sources of PFAS have been identified on-site. No further risk assessment is required.	
Hazardous Installations	No hazardous installations that could potentially prejudice the proposed construction of highly sensitive residential dwellings have been identified within influencing distance of the subject site.	

PREVIOUS REPORTS

E3P is aware that a previous ground investigation report has been completed for the site RSK ENSR in September 2006.

E3P GROUND INVESTIGATION

Ground Investigation Works	E3P has completed an intrusive ground investigation comprising: 14 x mechanically excavated trial pits, 6 x window sample boreholes, 3 x Cable percussion boreholes, and Construction of six environmental monitoring installations.

Ground Conditions	**Made Ground – 0.0m bgl to 4.5 m bgl** Made Ground deposits were encountered within all but one (WS106) location to depths ranging between 0.6 m bgl (TP104) and 4.5 m bgl (WS104). The shallowest Made Ground was encountered at the eastern (average 0.98 m) and western edges (average 0.85 m) of the site with thicker Made Ground through the centre (average 1.98 m). the deepest Made Ground appears to be in the southwest of the site where the thickness of 4.5 m (WS104) and 3.1 m (TP114) were recorded. TP104 and TP113 were not able to penetrate the Made Ground due to refusal on obstructions. Made Ground deposits are variable but in general comprise blackish-brown gravelly fine to medium sand. The gravel fragments comprise concrete, brick, asphalt, ceramic, clinker and slate. Locally, pieces of glass, rebar and electrical wiring were also encountered along with inclusions of ash. Cobbles-sized fragments comprised brick and concrete.
	Drift – 0.2m bgl to 10m bgl Drift deposits were encountered in all locations and typically comprise firm to stiff CLAY overlying fine to medium loose to medium dense SAND. Soft CLAY was encountered in TP110 below the Made Ground at 2.5 m bgl but this was recorded to become firm by 3.0 m bgl. In the deeper cable percussion boreholes CP101 and CP103 a deeper horizon of gravelly CLAY was recorded at depths of between 7.1-8.2 m bgl and 5.5-6.0 m bgl respectively. The deeper SAND horizons were recorded to become very dense from ca. 7.0 m bgl.
	Solid – Not encountered
	Groundwater Groundwater strikes were recorded as slow ingress in the exploration holes at depths of between 1.3 m bgl and 6.0 m bgl. Monitoring to date has not recorded significant recharge in the monitoring wells.

CONTAMINATED LAND ASSESSMENT

Initial Conceptual Site Model	The site was historically an iron foundry and packaging factory with an off-site landfill site appearing to encroach into the southern sector of the site. Based on these on-site uses, potential sources of heavy metals, polycyclic aromatic hydrocarbon (PAH), total petroleum hydrocarbon (TPH), asbestos and ground gas may be present. **Human Health** Metals, PAH, TPH and asbestos pose a risk to construction workers through dermal contact, ingestion and inhalation of soil particles and fibres when impacted soils are exposed. The risk to end users also includes the consumption of homegrown vegetables to which impacted soils may be present in garden and landscaped areas. **Controlled Waters** Mobile contaminants such as TPH and PAH could migrate laterally and vertically through permeable strata. The risk to controlled waters may be limited due to the lower sensitivity of the underlying aquifer and lining to the adjacent Ashton Canal channel and likely groundwater flow to the south following topographic gradient.

	Ground Gas Fill material and Made Ground may contain organic material that could generate ground gas such as methane and carbon dioxide. These gases could migrate through permeable strata and impact future structures and dwellings.
Human Health	Assessment against a residential end-use with plant uptake has identified elevated arsenic, lead, zinc and asbestos as well as elevated PAH compounds. These are widespread throughout the Made Ground. The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private gardens, landscaping and public open space to remove any potential for direct exposure to impacted soils. The specific design and installation process for the appropriate cover systems will be clearly defined within the site remediation and enabling works strategy.
Controlled Waters	Widespread arsenic, lead and PAH impact has been identified in the soil, with leachate testing indicating potentially mobile impact from arsenic, lead and zinc. The groundwater beneath the site is likely at depth and based on the site setting is not considered a highly sensitive receptor being a secondary B aquifer and with no groundwater abstraction within the drift. A groundwater abstraction is identified ca. 650 m to the west but this is for evaporative cooling and is likely abstracting from the Chester Formation Sandstone and not the Manchester Marl which underlies the subject site. A foundation design has not been determined but it is likely that for the majority of low-rise plots, these can be found in underlying clay or re-engineered Made Ground using vibro-replacement stone columns. Either option would not generate any new preferential vertical pathways. Further assessment of the risk associated with a piled foundation may be required. Ashton Canal is located at the northern boundary. However, this is not considered to be a sensitivity receptor as it is a lined artificial channel. The canal will be ca. 2.0 m deep and groundwater monitoring has confirmed that groundwater is greater than is at the south of the site; significantly below the base of the canal (3.68 m bgl – WS104). This would indicate a gradient away from the canal and provides evidence that the canal is not in continuity with groundwater. If subsequent monitoring of the wells does not provide an opportunity to sample shallow groundwater then testing of the canal may assist in demonstrating that there is no risk.
Ground Gas	Initial results have indicated that the site is classified as CS1-Low Risk. The full assessment will be completed in due course.
Potable Water Infrastructure	Barrier pipe will likely be required.

COAL MINING ASSESSMENT

Preliminary Assessment	The site is located within a Coal Mine Reporting Area but there are no crops, shallow seams or shafts within 1 km of the site. Furthermore, the site is not within a Development High-Risk Area with any coal deposits likely at significant depth beneath the Manchester Marl Formation.

GEOTECHNICAL ASSESSMENT

Underground Obstructions and Subterranean Hazards	Relict sub-structures have been identified across the site and as part of the process of creating a suitable platform for development, all relict sub-structures will need to be excavated and removed beneath new structures and infrastructure. This will facilitate the construction of the proposed plots as intended. A former refuse tip was identified in the south and with WS104 indicating up to 4.5 m of Made Ground compared with 0.8 m in TP109 there is an inference of a possible high-wall in this area. A culvert may be present beneath the site, however, its exact location and status have not been determined to date.
Allowable Bearing Capacity (ABC)	Across much of the site, the natural strata comprise CLAY overlying SAND. The CLAY has been determined to have an ABC ranging from 93–178 kN/m^2 at between 1.0 m and 2.0 m bgl and 112–268 kN/m^2 between 2.0 m and 3.0 m bgl. An area of soft CLAY was recorded in TP110 at 2.50 m where an ABC of 35 kN/m^2 has been recorded. The underlying SAND can be described as medium dense increasing to very dense from depths ca. 8.0 m bgl level with ABCs ranging from 139–238 kN/m^2 between 2.0 and 3.0 m bgl. At greater depths of between 4.0 and 5.0 m bgl two locations recorded loose SAND at ca. 5.0 m bgl. This may be due to perched groundwater. However, as noted above, in the deeper cable percussion boreholes the SAND becomes increasingly dense to refusal at ca 8.0 m bgl with SPTs greater than 50 for between 245 mm and 265 mm. This would indicate an ABC of greater than 400 kN/m^2.
Foundation Options	At this time it is not possible to accurately define the foundation types due to the absence of a detailed tree survey and final development levels and layout; however, based on our experience with similar sites, we would anticipate that the final foundation solution would be a combination of the following: • Shallow strip foundations bearing on firm to stiff gravelly CLAY from circa 1 m bgl, albeit limited areas and subject to proposed FFLs; • Trench fill to support reinforced strip foundations in areas of variable ground and/or potential tree influence. • Vibro Replacement Stone Columns (subject to re-engineering of the Made Ground) • Piled foundation set within the dense SAND for high-rise apartments or where sensitive infrastructure is present.

	Given the requirements for a large-scale phase of enabling works, it is highly likely that the most suitable foundation solutions for the proposed structures will be Vibro Replacement Stone Columns to support a suitably reinforced spread footing. Consideration must be given to the adjacent canal features and adjacent superstructures. Should an active culvert be present beneath the site piles may be required to transfer the load below the feature and prevent unacceptable structural loading.
Foundations Near Trees	Foundation depths within the conjectured influence of former, existing or proposed trees will need to be deepened to ensure that structural loading bears within the underlying target founding stratum, which cannot be subject to volumetric instability associated with fluctuation in moisture content.
Heave Precautions Near Trees	Given that the underlying clay is of low and medium volume change potential and for design purposes a medium volume change potential should be considered. As the site is underlain by medium volume change potential clay, appropriate heave precautions will be required for the sub-structure design as a part of the structural engineer's appraisal where in influencing distance of existing or proposed trees.
Building Floor Slabs	Ground-bearing floor slabs are not considered viable given the anticipated depths of Made Ground > 600 mm and shallow cohesive soils.
Soakaway Drainage	The Made Ground and underlying granular soils are cohesive in nature and impacted by low-level inorganic and hydrocarbon compounds which would preclude the use of infiltration drainage systems.
Sulphate Assessment	Concrete classification will be DS1 AC1s in the majority of cases. A single DS3/AC2s classification has been identified at the site.
Highway and Infrastructure Construction	Where a proposed highway or infrastructure is to be constructed in these areas, remediation works will be required to ensure the site is engineered to a suitable geotechnical design specification.
CBR Design %	Granular soils can be re-engineered to ensure 5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods. However, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.
Enabling Earthworks	Development levels are unknown at this time; however, engineering works to remove the relict sub-structures will be required. Any excavated material and resulting void will require backfilling the geotechnically suitable material. As part of the earthworks design, materials should be assessed and characterised prior to re-use in the construction of upfill to a geotechnical design. All future earthworks should be completed in accordance with a Geotechnical Design Report (GDR) that will consider the ground model within the context of the potential for settlement induced by surcharge from earthworks, dynamic and permanent loading of the development and all known hazards.
Civil Engineering Excavations	Due to the presence of granular strata, care will be required if undertaking any on-site dewatering to ensure that this does not cause a stability hazard to adjacent sites or structures.

Waste Characterisation	Any material that is to be disposed off site should undergo assessment using Technical Guidance WM3: *Waste Classification – Guidance on the classification and assessment of waste*. This can be done upon request and in line with the Environment Agency sampling frequencies.

RECOMMENDATIONS

Based on the findings of the Geoenvironmental site assessment and the various conclusions drawn, the following additional works are recommended to be completed in due course:

- Completion of the gas monitoring and ground gas assessment.
- Consideration of sampling the Ashton Canal,
- Plot-specific foundation schedule (upon receipt of the final development levels).
- Geotechnical Design Report.
- Geotechnical Earthworks Specification
- Remediation and enabling works strategy.
- Specification for Mitigation of Hazardous Ground Gases and Verification Plan.

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17-548-R1-010 – Conceptual Site Model
17-548-R1-011 – Groundwater Conceptual Site Model
17-548-R1-012 – Developed Conceptual Site Model

1. INTRODUCTION

1.1. BACKGROUND

Connell Developments Ltd (the client) commissioned E3P to undertake a Phase I and II Geoenvironmental Site Assessment at Crabtree Lane, Manchester, M11 4GU.

This report is required to determine potential contaminated land liabilities, remediation requirements and geotechnical engineering works that will be required as part of the proposed development for a mixed low-rise and high-rise residential development.

1.2. PROPOSED DEVELOPMENT

A detailed site layout has not been provided. However, the scheme is likely to comprise a mixed low-rise and high-rise residential development with associated gardens/landscaping, estate roads and infrastructure. A proposed development plan has not yet been submitted to E3P.

A snapshot of the proposed development area is indicated in Figure 1.

Figure 1 Snapshot of Proposed Development Area (Blue Area Denotes Leasehold Land)



1.3. OBJECTIVES AND SCOPE

The objectives of the geoenvironmental investigation are as follows:

- Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available to complete a desk study in line with Environment Agency (EA) document Land Contamination: Risk Management (LCRM) (updated June 2023).

- Undertake a phase of sampling and analysis to provide an overview of the environmental issues identified.
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site concerning the site's future use and off-site receptors.
- Assess the geotechnical information and provide recommendations concerning foundations, pavement construction and floor slabs.
- Assess the coal mining-related information and provide recommendations regarding any future treatment; and,
- Provide recommendations regarding future works required.

1.4. SOURCES OF INFORMATION

Background information was sought from the following sources:

- Groundsure Enviro+Geo Insight Search Reference GS-M9N-NZ9-NQP-FQN;
- Historical mapping dated 1848 to 2024. A selection of historical maps is reproduced in APPENDIX VI;
- Online planning records held by Manchester City Council;
- Consultations with representatives of Manchester City Council;
- Magic Map Groundwater Vulnerability Map;
- Radon: Guidance on protective measures for new buildings (BRE Document BR 211, 2007);
- British Geological Survey Map;
- Groundsure IO database;
- https://zeticauxo.com/downloads-and-resources/risk-maps/;
- https://flood-map-for-planning.service.gov.uk
- *https://en-gb.topographic-map.com/*
- Search results | Catchment Data Explorer | Catchment Data Explorer

1.5. SCOPE OF WORKS

The scope of works includes the elements included in Table 1.

Table 1 Scope of Works

PRELIMINARY REPORTING
Phase 1 Geoenvironmental Assessment
GROUND INVESTIGATION
Design of suitable ground investigation
Window sample probeholes with the construction of environmental monitoring installations
Deep cable percussive boreholes
Mechanically excavated trial pits
Soil and groundwater sampling
TESTING AND MONITORING
In-situ geotechnical testing
Chemical and geotechnical analysis
Groundwater monitoring
Ground gas monitoring
ASSESSMENT AND REPORTING
Factual and interpretative reporting
Contamination risk assessment and conceptual site model
Geotechnical assessment and interpretation

1.6. LIMITATIONS

The limitations of this report are presented in APPENDIX I.

1.7. RISK CLASSIFICATION

The description of risk classification and the likely action required as set out in CIRIA C552 are included in APPENDIX III.

1.8. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed or with whom an assignment has been agreed. Should any third party wish to use or rely upon the report's contents, written approval must be sought from E3P; a charge may be levied against such consent.

2. SITE SETTING

2.1. SITE DETAILS

Table 2 Site Details

Site Address	Crabtree Lane, Manchester, M11 4GU.
National Grid Reference	E 388825, N 398057.
Site Area	0.69 Ha.
Site Ownership	Freehold with a small area in the southern sector subject to leasehold.

The Glossary presented in APPENDIX II defines all acronyms used within this report.

A site location map is presented in APPENDIX IV as Drawing 17-548-001.

2.2. CURRENT SITE USE

A desk-based walkover was completed by an E3P representative, with the full details included in Table 3.

Table 3 Site Description

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Occupancy/Use	The subject site is an irregular-shaped parcel of land located east of Crabtree Lane and currently occupied by a service yard. The site is currently being cleared with stockpiled material being screened and crushed.	
Structures	There are no permanent structures on site though brick walls form the northern perimeter of the site.	
Retaining Structures	No retaining structures have been identified on-site.	
Access	Pedestrian and vehicular access can be gained from the east of Crabtree Lane through an access gate.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Slope	The site is topographically level though a small area of raised slab is present in the northeast of the site. There are mounds of materials on the site which are currently being processed for removal.	
Vegetation/Ecology	Mature trees are present along the western/southern/eastern boundary of the site. There are no features which are considered to be ecologically sensitive within the subject site.	
Hazardous Material Storage	No above-ground storage tanks (ASTs) or underground storage tanks (USTs) were observed during the preliminary desk-based walkover. Temporary diesel storage and skips containing waste materials are currently present associated with the site clearance works.	
Asbestos-Containing Material (ACM)	No evidence of ACM was noted across the site during the initial site inspection but its presence in the material stockpiles cannot be entirely discounted. E3P understands that the current stockpiles will be removed from site ahead of the proposed divestment.	

FEATURE	DESCRIPTION	PHOTOGRAPHIC EVIDENCE
Polychlorinated Biphenyls (PCBs)	No equipment that may contain PCBs, such as transformers or electric substations, is identified on the Site.	
PFAS/PFOA	No evidence of PFAS/PFOA has been identified on site.	
Waste Storage	There are currently skips stored on the site that relate to the site clearance operations being completed.	
Drainage	A formal drainage survey has not been completed; however, a review of service records held by United Utilities indicates that there are no sewers on-site and no relict storm drainage features were noted. A culvert is recorded on historical maps but no evidence for this was determined during this phase of works.	

2.3. SURROUNDING AREA

The immediate surrounding area land uses are summarised in Table 4.

Table 4 Surrounding Land Uses

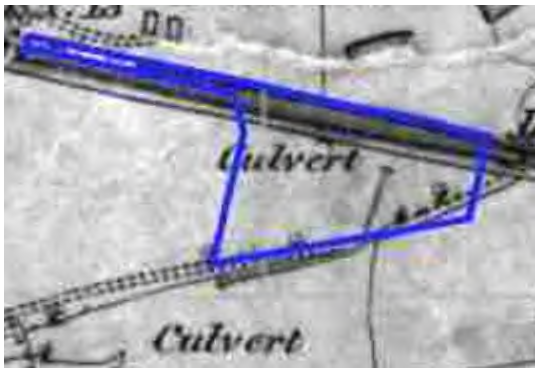
DIRECTION	LAND USE
North	Ashton Canal and Commercial Units
East	Allotment Gardens
South	Higher Openshaw Community School and Residential Properties
West	Commercial Units

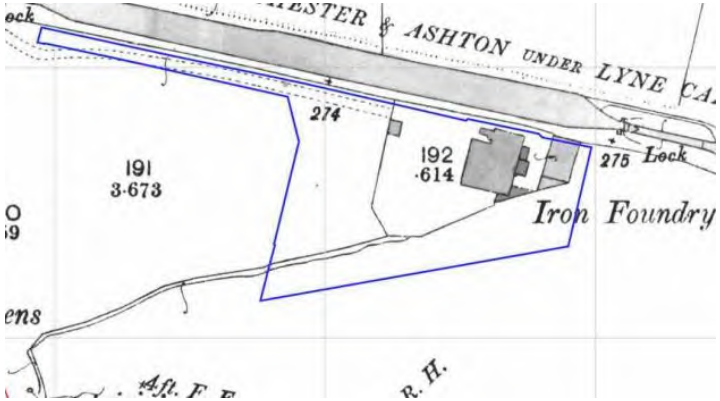
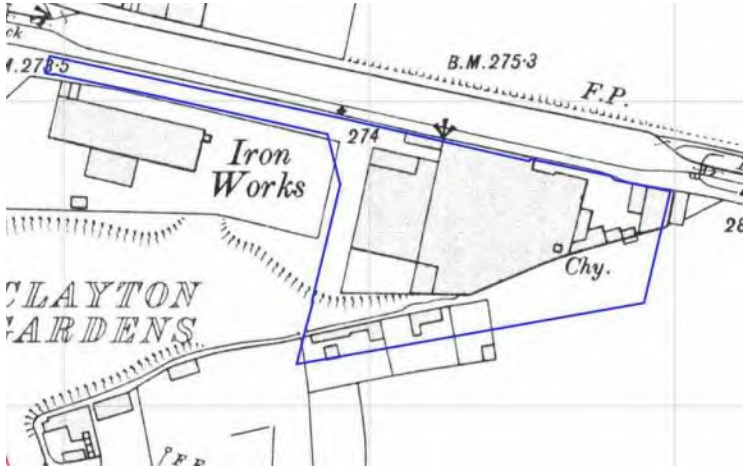
3. SITE HISTORY

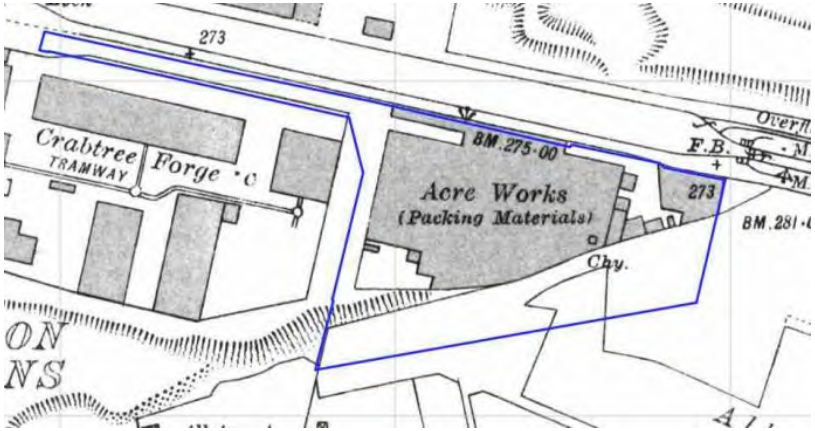
3.1. ON-SITE HISTORICAL DEVELOPMENT

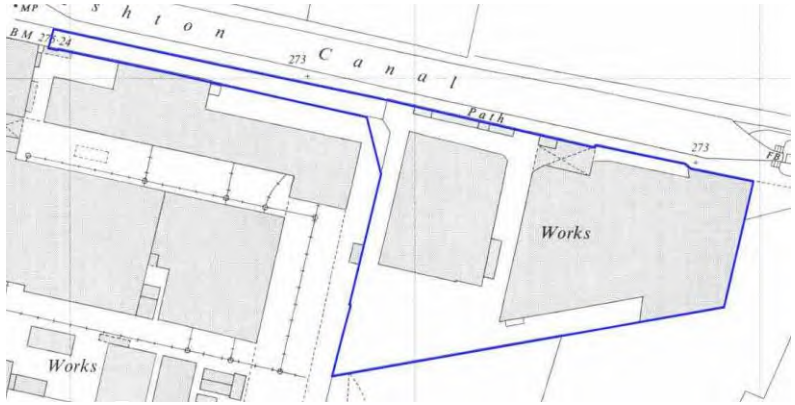
A review of historical mapping and historical aerial imagery pertinent to the site is summarised in Table 5. In addition, historical site features are presented in Drawing No 17-548-003 in APPENDIX IV.

Table 5 Historical Development

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1848 1:10,560	The site is recorded as undeveloped land. However, there is a culvert present.	
1890-1892 1:10,560	An Iron Foundry is recorded on the site comprising two buildings in the west.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1893 **1:2,500**	The earliest large-scale mapping provides a greater detailed insight into the Iron Foundry. The map also suggests that an open watercourse may have been present in the southwest though the culvert is no longer marked.	
1908 **1:2,500**	The iron works have expanded and there is now a chimney detailed in the central eastern sector of the site. Markings also suggest that the site levels have been raised with a slope marked in the southwest.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1932-1933 1:2,500	The site's layout remains the same but is has now been relabelled Acre Works (Packing Materials). The watercourse is no longer recorded with markings suggesting it has been covered or infilled.	
1949-1950 1:1,250	The site remains the same. However, the more detailed mapping demonstrates that the site has multiple buildings as opposed to one large building which is detailed in the smaller scale mapping. A refuse heap is also present in the south of the site but is considered to be predominantly located to the south.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1964-1968 1:1,250	The site remains unchanged but has been detailed as an unspecified works. There is no longer a refuse heap present in the south of the site.	
1992-1994 1:1,250	There are no significant changes recorded when compared with the previous map.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
2003 **1:1,250**	The unspecified works has been demolished and the site is vacant land with no structures recorded on it.	
2009 **Satellite** **Imagery**	There are no significant changes when compared with the previous map.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
2019 Satellite Imagery	The rough scrub vegetation has been cleared from site.	
2024 Satellite Imagery	The site is occupied by a service yard. Site activities at the service yard include the loading and unloading of materials and the storage of these materials.	

3.2. SUMMARY OF ON-SITE HISTORICAL DEVELOPMENT

The following summary points have been highlighted after a detailed review of the historical mapping series.

3.2.1. POTENTIAL HISTORICAL CONTAMINATION ISSUES

Historical buildings – Historical developments on-site may have been constructed with ACM which may be present within Made Ground from the demolition of these structures.

The industrial use as an iron works/packing materials/unspecified works suggests the potential for heavy metals (copper, zinc, lead and chromium), waste oils (PAHs) to be present. In addition, with a chimney being recorded on this, combustion processes are likely to have taken place. While likely coal, there is the potential for diesel or heating oil-fired systems, suggesting the potential for petroleum hydrocarbons.

3.2.2. POTENTIAL HISTORICAL GEOTECHNICAL ISSUES

Obstructions associated with the former iron works/foundry foundations, sub-strucutres and floor slabs may be present. Additionally, a culvert may be present across the site and an easement may be needed.

3.3. OFF-SITE HISTORICAL DEVELOPMENT

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 100 m radius of the Site is summarised in Table 6.

Table 6 Surrounding Historical Development

SURROUNDING FEATURE	DISTANCE	DATES	DIRECTION
Unspecified Tank **Then: no longer marked**	0 m	Pre 1979–Pre2009 Pre2009–Present	South
Refuse Heap **Then: no longer recorded**	4 m	Pre 1949–Pre 1964 Pre 1964–Present	South
Railway Sidings **Then: no longer recorded**	5 m	Pre 1938–Pre 1994 Pre 1994–Present	West
Forge **Then: marked as disused**	5 m	Pre1922-Pre2009 Pre2009-Present	West
Chemical Works **Then: marked as Works** **Then: no longer recorded**	10 m	Pre 1922–Pre 1964 Pre 1964–Pre 1979 Pre 1979–Present	West
Brick Kilns **Then: recorded as Chemical works** **Then: no longer recorded**	12 m	Pre1848-Pre1894 Pre1894-Pre1949 Pre1949-Present	Northwest
Limepit **Then: no longer recorded**	18 m	Pre1932-Pre1952 Pre1952-Present	Northeast
Works **Then: no longer recorded**	57 m	Pre1981-Pre2003 Pre2003-Present	Northeast

3.4. PLANNING HISTORY

E3P has reviewed online planning records held by Manchester City Council, and a list of the relevant documents are summarised in Table 7 below.

Table 7 Planning History

PLANNING REFERENCE	PLANNING APPLICATION	PERTINENT DOCUMENTS
13891/FO/2023	Erection of 9 no. units	Intrusive geoenvironmental and geotechnical site assessment Topographical survey and existing elevations Arboricultural impact assessment
138523/DEM/2023	Prior approval for the demolition of the existing industrial buildings	Topographical survey Ecological appraisal
134463/FO/2022	Erection of 3 x 3 storey apartments	Flood risk assessment Tree survey
085106/TEL/2007/N2	Erection of 11.7m high monopole	Supporting information

3.5. PREVIOUS REPORTS

E3P has been provided with an RSK ENSR Report dated September 2006. The report was entitled Site Investigation, Acre Works, Louisa Street, Manchester and comprised a desk study and intrusive ground investigation. The main environmental findings of this report are summarised below:

- RSK ENSR reported that Made Ground was present in all their exploration locations to a maximum depth of 4.5 m bgl. The Made Ground was described as consistent and generally comprising of black, ashy gravelly sand containing varying concentrations of clinker, slag and brick.
- In all but one location, natural strata were reported to comprise an upper horizon of soft to firm CLAY. RSK ENSR then reported this stratum to be underlain by SAND with bands of soft to firm CLAY.
- Groundwater was reported to have been encountered as a slow seepage in a deeper borehole at a depth of 5.00 m bgl.
- Laboratory testing was completed on selected soil samples and the results were then compared with Soil Guideline Values that were appropriate for the time.
- This assessment identified widespread elevated concentrations of arsenic (max 70 mg/kg) and copper (max 1420 mg/kg); locally elevated lead (max 2240 mg/kg); and a single isolated cadmium (8 mg/kg), nickel (64 mg/kg) and zinc (2220 mg/kg).
- TPH analysis was completed by RSK ENSR reportedly identified elevated C12-C16 aromatic compounds. However, it should be noted that the screening values used at this time were extremely conservative.
- PAH analysis and assessment identified elevated naphthalene in two locations (max 7.05 mg/kg); fluoranthene in one location (max 165 mg/kg); benzo(a)anthracene in three locations (max 64.50 mg/kg); chrysene in three locations (max 73.5 mg/kg); and benzo(b) fluoranthene in two locations (max 63.20 mg/kg).
- Gas monitoring recorded a maximum methane concentration of 0.2 % and a maximum carbon dioxide concentration of 8.5%. The lowest oxygen concentration was 10.5%. Significant flow was not recorded during the RSK ENSR monitoring visits.

4. ENVIRONMENTAL SETTING

4.1. GEOLOGY

The British Geological Survey (BGS) map (Sheet 085) for the Site (1:50,000, Solid and Drift editions) and online records indicate the area is underlain by the geological sequence presented in Table 8.

Table 8 Summary of Underlying Geology

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Drift	Till, Devensian - Diamicton	SAND, CLAY and GRAVEL	Secondary undifferentiated
Solid	Manchester Marls Formation	MUDSTONE	Secondary B aquifer

E3P has reviewed the BGS database, which has not identified any boreholes in close proximity, from which to compare the published geology above.

4.2. HYDROGEOLOGY

The Groundsure report indicates that the site is not located within a groundwater source protection zone. Furthermore, there are no potable abstractions within 1 km of the Site. The closest active groundwater abstraction point is located 687 m west of the site.

Based on the local topography and the location of surface watercourses within the proximity to the site boundary, it is likely that shallow groundwater, if present, will flow in a southwesterly direction.

4.3. HYDROLOGY

Surface water features within 50 m of the subject site are summarised in Table **9**.

Table 9 Surface Water Features

SURFACE WATER FEATURE	EA CLASSIFICATION	QUALITY	DISTANCE (m)	DIRECTION
Ashton Canal	Canal	Moderate	Adjacent	North
River Medlock	Main River	Moderate	1.3 km	North (at the closest point)

Historical maps indicate the presence of a culvert on-site ca. 1848 and that this may have flowed into a watercourse called Clayton Brook ca 50 m to the south. The culvert is not recorded on any subsequent maps and by 1968 Clayon Brook is no longer recorded. United Utilities sewer plans record a 600 mm piped watercourse to the south of Crabtree Forge which may be the historical Clayton Brook.

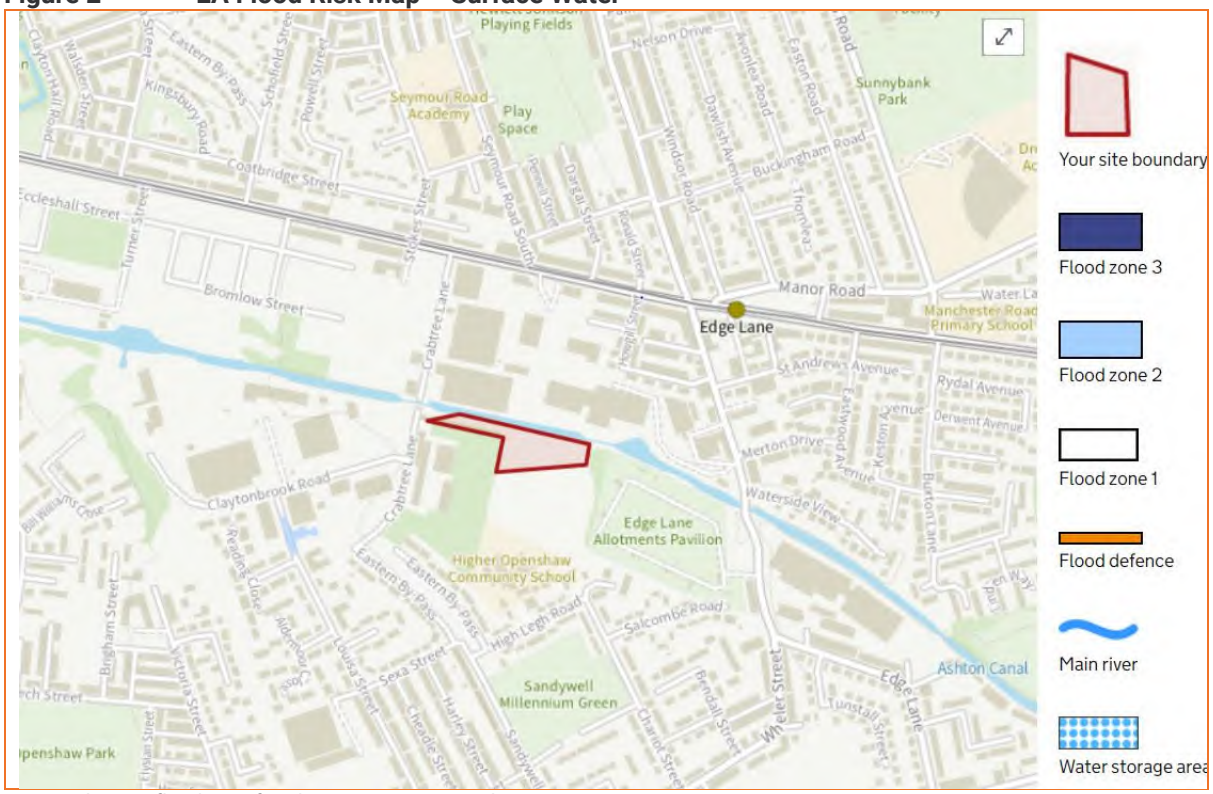
The site is predominantly located within a currently defined “Flood Risk Zone 1”, defined as land assessed as having less than 1 in 1,000 annual probability of river or sea flooding (< 0.1%) and, as such, is considered to be unaffected by river flooding.

In addition, the Groundsure report states there is a limited potential for groundwater flooding at the Site.

The Environment Agency (EA) Flood Risk Maps for the Site is presented in

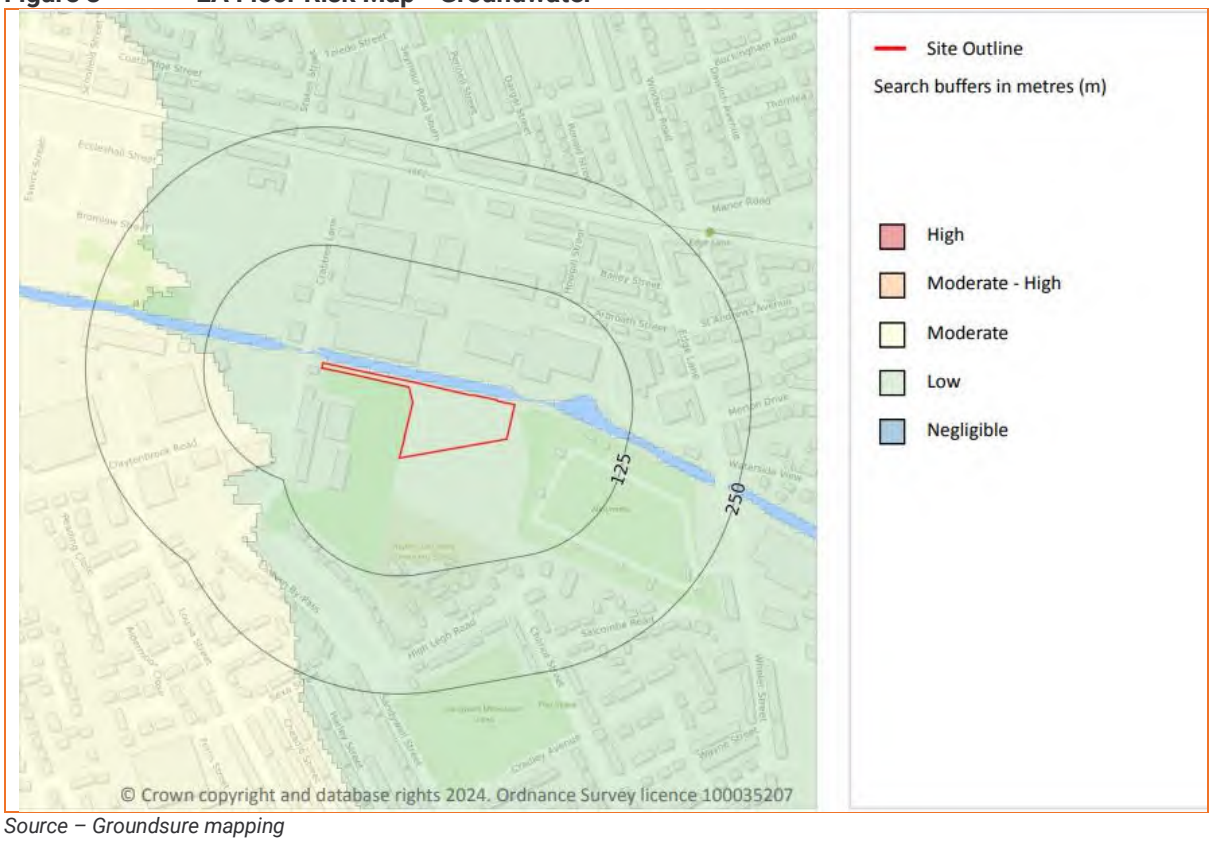
Figure 2 and Figure 3.

Figure 2 EA Flood Risk Map – Surface Water



Source - https://flood-map-for-planning.service.gov.uk/

Figure 3 EA Floor Risk Map - Groundwater



Source – Groundsure mapping

4.4. RADON RISK POTENTIAL

The Groundsure report indicates the site is situated in an area where less than 1% of homes are above the "Action Level" and that the BGS reports that full radon protective measures are not necessary for the construction of new dwellings or extensions.

4.5. LANDFILL SITES

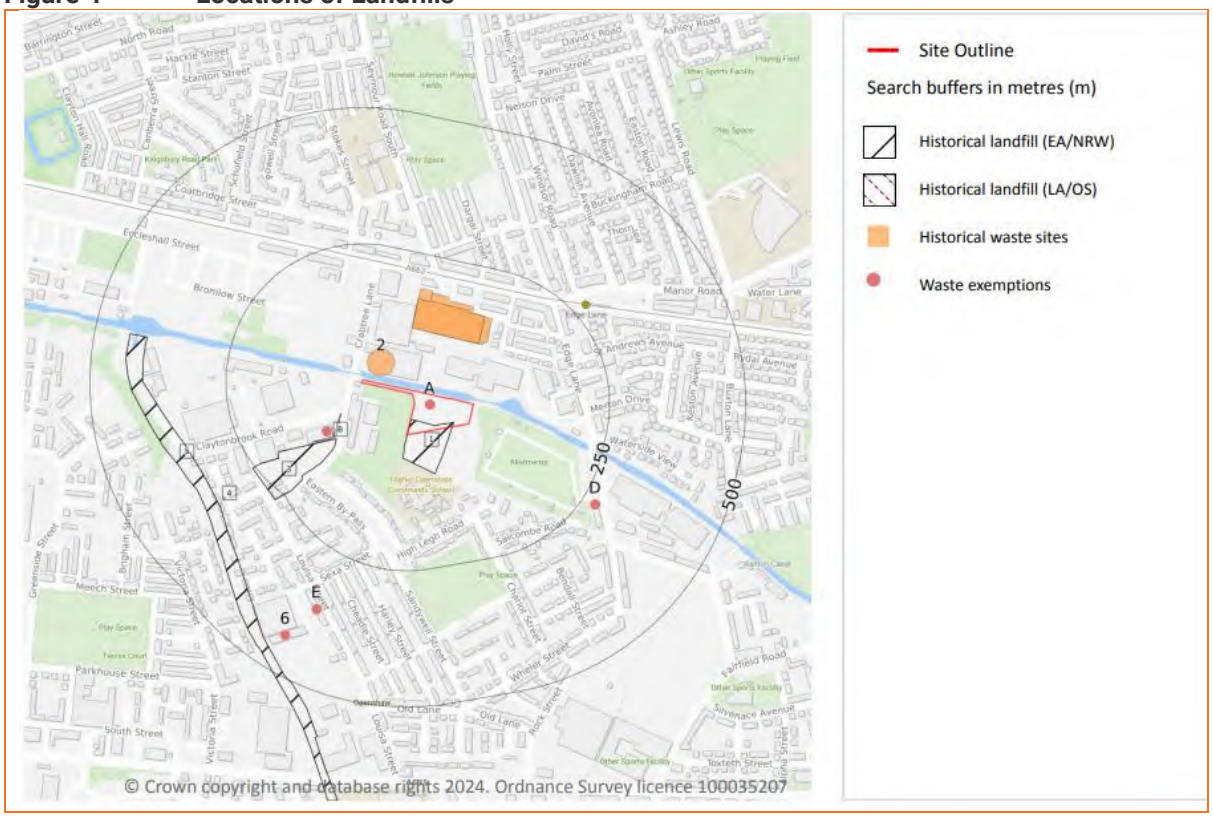
Two landfills are within a 250 m radius of the site. The details of these are presented in Table 10 below.

Table 10 Licensed Landfills

LANDFILL NAME	OPERATING DATE	ACCEPTED WASTE	DIRECTION
Crabtree Forge – Site Reference: RD/LIC/216/81 GDO F049	31/12/1942 - 31/12/1992	Inert, Industrial	South
Site Reference:F048	Unknown	Unknown	113 m West

A screenshot of the mapping showing landfill locations within 250 m radius of the site is included in Figure 4.

Figure 4 Locations of Landfills



The Crabtree Forge and Clayton Industrial Estate landfill sites are recorded as a historical landfill and pre-date the Control or Pollution Act (COPA) and current environmental permitting requirements.

4.6. WASTE MANAGEMENT LICENSES AND ENVIRONMENTAL PERMITS

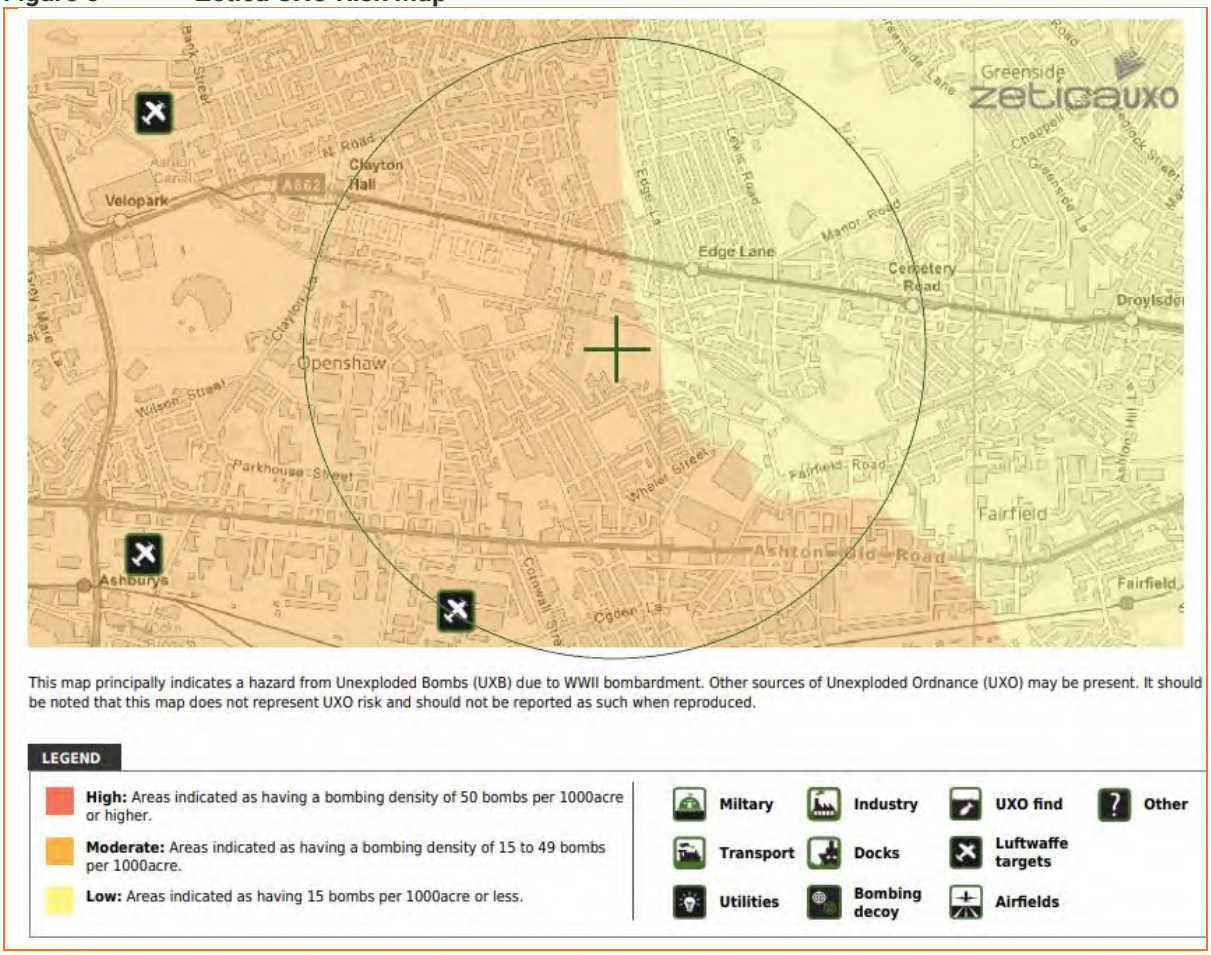
Two waste exemptions have been recorded on-site; for the use of waste in construction and for the screening and blending of waste. Supplementary to this, there are two further exemptions 112 m west of the site, for the storage of waste in a secure place and the use of waste in construction.

4.7. UNEXPLODED ORDNANCE

The regional unexploded bomb risk map from Zetica (2014) indicates that the Site is in an area at moderate risk from possible unexploded ordnance (UXO) resulting from the Second World War. The Zetica UXO Risk Map is presented in
Figure **5**.

A Detailed UXO Risk Assessment is included in APPENDIX XI.

Figure 5 Zetica UXO Risk Map



Source - https://zeticauxo.com/downloads-and-resources/risk-maps/

4.8. INDUSTRIAL LAND USES

The site is located within a predominantly industrial area, therefore several industrial land uses have been identified within a 100 m radius of the site, summarised in Table 11.

Table 11 Industrial Land Uses

INDUSTRIAL LAND USE	DISTANCE	DIRECTION	STATUS
Tank	3m	West	Inactive
Tank	6m	Northwest	Active
Travelling Crane	12m	Southwest	Active
Travelling Crane	35m	Southwest	Active
Mast	44m	West	Active
Works	76m	Northeast	Active

4.9. SITE SENSITIVITY ASSESSMENT

The site is assessed to be located within a "Moderate" sensitivity setting, as discussed in Table 12.

Table 12 Site Sensitivity Assessment

SENSITIVITY PROFILE	DISCUSSION	RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The Groundsure report indicates that the Site is not located within a groundwater source protection zone.	Low
Distance to the Closest Groundwater Abstraction Point	687 m west.	Moderate
Aquifer Classification in Superficial Drift Deposits	Secondary undifferentiated.	Low
Aquifer Classification in Bedrock	Secondary B aquifer.	Low/Moderate
Is the Site Underlain by Low-Permeability Drift to Depths in Excess of 10 m?	The underlying superficial deposits are likely to comprise gravelly sands interbedded with low-permeability clay soils to depths in excess of 5 m, which may reduce the potential for mobile phase contaminants to migrate towards the bedrock aquifer or adjacent watercourses.	Low/Moderate
Is the Site Located Within 50 m of a Surface Watercourse?	The Ashton Canal is located to the north of the site. A culvert is recorded at the site but only on historical maps. Its current presence has not been established.	Moderate
Sensitive Land Uses	Higher Openshaw Community School is located 70 m to the south and allotment gardens are situated adjacent to the site.	Moderate
Sensitive Ecological Receptors	No environmental designations are recorded within a 500 m radius of the site.	Low
OVERALL SITE ENVIRONMENTAL SENSITIVITY		**Low/Moderate**

4.10. REGULATORY DATABASE

The information summarised in Table 13 has been obtained from a commercially available environmental database. The summary table only includes records from within 250 m of the subject site and is not otherwise detailed in the report.

Table 13 Summary of Environmental Data

RECORD	ENTRIES WITHIN 250 m	DETAILS
Contaminated Land Register Entries and Notices	6	All six sites identified as contaminated land was identified in either 2004 or 2005 and are all described as "contaminated land owing to the presence of arsenic, heavy metals, and polyaromatic hydrocarbons". The closest of these sites is located 116 m southwest of the site.
Authorised Industrial Processes (IPC/IPPC/LAPPC)	1	105 m north – Petrol vapour recovery Status: Historical Permit Type: B
Fuel Stations Entries	1	22 m northeast of the site.
Licensed Radioactive Substances	0	None Identified
Enforcements, Prohibitions or Prosecutions	0	None Identified
Discharge Consents	0	None Identified
Pollution Incidents	0	None Identified
Consents Issued Under the Planning (Hazardous Substances) Act 1990	0	None Identified
Control of Major Accident Hazard (COMAH) Sites	0	None Identified

4.11. REGULATORY CONSULTATIONS

E3P has contacted Manchester City Council (26/03/2024) and are currently awaiting a response from their representatives.

5. PRELIMINARY MINING ASSESSMENT

5.1. COAL MINING

The subject site is located within a Coal Authority Mining Reporting Area but is not located within a Development High Risk Zone. Furthermore, no coal seams or shafts are identified within a 1 km radius.

Based on the information reviewed and recorded underlying geology, no further coal mining risk assessment is considered necessary.

5.2. PRELIMINARY BRINE WORKINGS ASSESSMENT

The Site is not situated within the Cheshire Salt Field and no further assessment is considered necessary.

6. PRELIMINARY GEOTECHNICAL ASSESSMENT

6.1. GEOTECHNICAL DATA

Geotechnical data presented within a commercially available environmental database is summarised in Table 14.

Table 14 Summary of Geotechnical Data

HAZARD	DESIGNATION
Shrink-Swell Clay	Very low risk
Landslides	Very low risk
Ground Dissolution	Negligible Risk
Compressible Ground	Moderate Risk
Collapsible Deposits	Very low Risk
Running Sand	Very low risk

6.2. ARTIFICIAL LANDFORM AND GEOMORPHOLOGY

Based on the initial geological assessment, a review of available topographic data and pertinent mapping, E3P has undertaken a preliminary geomorphological evaluation of the landform and its possible mechanism for formation.

The site is likely to have been subject to anthropogenic change which will likely have resulted in a greater thickness of Made Ground. Upfilling and levelling works are likely to have occurred during construction and demolition to form a level plateau.

The LIDAR imagery shown in Figure 6 shows topography within the local area context.

Figure 6 Surface Lidar Data

(https://en-gb.topographic-map.com/)



6.3. GROUND CAVITIES AND SINK HOLES

Information within the Groundsure Report states the site is within an area of negligible hazard from rock solubility. When undertaking an online search for sinkholes in the area, multiple news reports identify sinkholes opening within eastern Manchester. However, every report relates the sinkhole to failed water infrastructure such as a sewer collapse and are not attributed to natural causes.

6.4. PRELIMINARY GEOTECHNICAL ASSESSMENT

Based on the desk-study information, the following geotechnical assessment has been made:

- Obstructions in previously developed areas of the site may remain in situ, particularly in the east of the site. Where below-ground obstruction and unsuitable fill require removal, the resulting voids will need to be backfilled with suitably engineered fill.
- A culvert and watercourse were historically mapped at the site.

7. INITIAL CONCEPTUAL SITE MODEL

Under EA LCRM (updated June 2023) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), and BS EN ISO 21365:2021 (Soil Quality – Conceptual models for potentially contaminated sites), E3P has developed a Tier 1 risk assessment comprising an initial conceptual site model (CSM) to identify potential contamination sources, migration pathways and receptors within the study area. An initial screening of the on and potential off-site sources of contamination has been undertaken in Table 15, with the more detailed initial CSM included overleaf as Table 16.

Table 15 Initial Contaminant Source Screening

SOURCE	SOIL	GROUNDWATER	GROUND GAS
ON-SITE			
Iron Works / Unspecified Works	Heavy Metals, PAH, TPHs, Asbestos, Sulphates	Heavy Metals, TPHs,	Carbon Dioxide and Methane
Refuse Tip	Heavy Metals, PAH, TPHs, Asbestos, Sulphates	Heavy Metals, TPHs,	Carbon Dioxide and Methane
OFF-SITE			
Railway Sidings	Heavy Metals, Asbestos, TPHs, PAHs	Heavy Metals, TPHs	Carbon Dioxide and Methane
Unspecified Tanks	Heavy Metals, TPH, PAH	Heavy Metals, TPH, PAH	Carbon Dioxide, Methane and VOCs
Brick Kilns	Heavy Metals, PAH Sulphates	Heavy Metals, TPHs	-
Forge	Heavy Metals, PAH TPHs, Sulphates	Heavy Metals, TPHs	-
Chemical Works	Heavy Metals, TPH, PAH, BTEX, S/VOC, asbestos	Heavy Metals, TPH, PAH	Carbon Dioxide, Methane and VOC
Lime Pit	Heavy metal	Heavy metals	-

After reviewing all environmentally pertinent information and the potential contaminant sources, the following initial conceptual site model has been developed for the site.

Table 16 Initial Conceptual Model

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
HUMAN HEALTH						
MADE GROUND, Railway Sidings, Tanks, Chemical Works, Iron Forge and Unspecified Works Heavy Metals, PAH, TPH	Accidental ingestion and/or dermal contact with contaminated soil and/or leachate. **PL1/PL2**	Human Health – construction workers	Likely	Medium	Moderate	Site personnel have a greater chance of coming into contact with potentially contaminated soils. Particularly during excavation and soil recovery works. **Recommendation:** Construction works are to be completed with appropriate PPE and welfare facilities.
		Human Health – end users	Unlikely	Medium	Moderate	The proposed development will be a residential end-use and there is potential exposure in garden and landscaped areas.
Tanks, Railway Sidings, Chemical Works, Iron Forge and Unspecified Works TPH, PAHs	Migration through permeable strata and preferential pathways.	Human Health – end users Human Health – Off-site receptors	Likely	Medium	Moderate	The desk study has identified the presence of off-site storage tanks which may be a source of TPH. Intrusive investigation and assessment will be required to determine the level of mitigation measures and/or remediation.
Made Ground, Tanks, Railway Sidings, Chemical Works, Iron Forge and Unspecified Works Asbestos (Asbestos containing materials (ACM) and loose fibres)	Inhalation (of fibres). Construction works disturbing bound material and releasing fibres. **PL3**	Human Health – construction workers, end land users, and users of adjacent sites	Likely	Medium	Moderate	Risk of inhalation of fibres during construction works. Disturbance of ACMs and dust derivatives from construction would increase risk to adjacent sites. Fibres present in garden and landscaped areas may pose a risk to end users. Intrusive investigation will be required to determine presence of ACMs and develop appropriate mitigation measures.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Made Ground Sulphate from potential ash within the Made Ground.	Sulphate attack on concrete. **PL6**	Building concrete	Likely	Medium	Moderate	Due to the presence of Made Ground on the site, there is the potential for sulphate associated with ash deposits on-site. This may pose a risk to building concrete. Intrusive investigation will be required to assess the concrete classification.
Made Ground Organic contaminants such as hydrocarbons, solvents	Ingestion of tainted water supply. **PL7**	Human Health – End Users Water pipeline	Likely	Medium	Moderate	Impacted soil may be present at pipeline depth across the west of the site (0.75–1.35 m). Intrusive investigation is required.
Made Ground Phytotoxic contaminants	Direct contact (plant uptake). **PL8**	Flora	Likely	Medium	Moderate	Likely probability as contamination is considered possible, which may be taken up by flora in soft landscaping/gardens. Intrusive investigation is required to determine if a cover system is required.
CONTROLLED WATERS						
Groundwater	Contact with contaminated groundwater. **PL2**	Human Health – site personnel	Low likelihood	Medium	Moderate	Impacted groundwater may be encountered by construction workers during earthworks. Construction control measures can mitigate this risk.
	Contaminants leached from the Made Ground through infiltration and percolation of rainwater. **PL5**	Underlying Secondary B aquifer (solid) Ashton Canal Culvert	Likely	Medium	Moderate	The site is thought to be underlain by SAND/CLAY/GRAVEL. Therefore, the granular layers may provide a pathway to the underlying aquifer if they are penetrated by deeper foundations to the underlying secondary B aquifer. The canal is not considered to be a plausible receptor as this is likely lined with clay and not in continuity with site groundwater.

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	LEVEL OF RISK	JUSTIFICATION
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
						A culvert is recorded on historical maps. It is not known if it is still present. If it is it will likely be wihtin an brick or concrete structure and unlikely to be in continuity with groundwater.
GROUND GAS						
Ground gases (methane and carbon dioxide)	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (asphyxiation or explosion)	Human Health – site personnel	Likely	Medium	Moderate	Ground gases may migrate through permeable strata to enter proposed buildings. A period of ground gas monitoring will be required to determine the gas regime for the site.
		Human Health – end users	Likely	Medium	Moderate	
		Infrastructure and services	Likely	Medium	Moderate	
Radon	Inhalation of ground gas. **PL4** Accumulation of ground gas in confined spaces (carcinogenic)	Human Health – site personnel	Unlikely	Medium	Low	Radon mapping has identified the site is within an area not at risk from radon. Radon mitigation measures will not be required.
		Human Health – end users	Unlikely	Medium	Low	

Main exposure pathways:
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation; PL5 = Vertical / Lateral Migration; PL6 = Corrosion of concrete; PL7=Tainting of water supply; PL8 = Uptake by plants.

Level of Risk
Very Low
Low
Low/Moderate
Moderate
Moderate/High
High

8. E3P GROUND INVESTIGATION

8.1. GENERAL OVERVIEW

A ground investigation has been designed based on the findings of the desk study, with exploratory holes advanced to target specific potential contaminant sources summarised in Section 7.0. The investigation has also been used to collect geotechnical information to assist in the design and construction of the proposed development.

The majority of the fieldwork was completed 12 March 2024 with the deeper Cable Percussion boreholes completed between 12 March 2024 and 14 March 2024. The works are summarised in Table 8.1.

8.2. LIMITATIONS OF THE INVESTIGATION

There were stockpiles and skips at the site which prevented localised access toward the northern boundary.

8.3. SCOPE OF INVESTIGATION

A summary of the fieldwork completed are included in Table 17.

Table 17 Summary of Fieldwork

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (m BGL)	MONITORING WELLS RESPONSE ZONE (m BGL)
Ground conditions including the presence/nature of obstructions	TP101-TP114	Trial Pit	3.4	n/a
Ground conditions – groundwater quality and presence of ground gas	WS101	Window Sample Probehole	5.45	0.5-3.5
	WS102		5.45	0.5-2.0
	WS103		5.45	2.0-4.0
	WS104		5.45	1.0-4.5
	WS105		5.45	1.0-2.5
	WS106		5.45	2.0-4.0
Deep ground conditions in the area of proposed high-rise residential apartment blocks	CP101	Cable Percussion	9.74	n/a
	CP102		9.74	n/a
	CP103		9.76	n/a

The sampling locations are illustrated in Drawing 17-548-005 (APPENDIX IV). The ground conditions encountered are indicated on the logs, which are provided in APPENDIX VII.

The locations were recorded using hand-held GPS and what3words to an accuracy of 3 metres.

Return visits were made to monitor installations for groundwater level and gas concentrations. In addition, selected wells were purged and samples of groundwater recovered for chemical analysis.

8.4. IN-SITU STANDARD PENETRATION TESTING (SPT)

In-situ geotechnical testing was conducted using the standard penetration test (SPT) and, where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the probehole logs in APPENDIX VI, presented in Table 38 and discussed in Section 12.0.

8.5. LABORATORY ANALYSIS

Selected soil samples were submitted for a range of chemical and geotechnical analysis, summarised in Table 18.

Table 18 Summary of Laboratory Analysis

CHEMICAL ANALYSIS
Metals
pH, total sulphate, water-soluble sulphate (2:1 extract)
Sulphide
Cyanide
Phenols
Total and speciated polycyclic aromatic hydrocarbons (PAHs)
Asbestos identification and quantification
Speciated and banded total petroleum hydrocarbons (TPHs)
Total Organic Carbon (TOC)
GEOTECHNICAL ANALYSIS
Atterberg limits determinations
Moisture content
Particle Size Distribution
Undrained Shear Strength in Triaxial Compression

8.6. STORAGE, PRESERVATION AND TRANSPORT OF SAMPLES

Measures taken to ensure the quality and integrity of the collected samples, from collection to receipt of the samples by the laboratory, are summarised in Table 19.

Table 19 Sample Integrity Information

SUBJECT	CHEMICAL SAMPLING	
Storage	**Soil**	**Groundwater**
	Glass jars supplied by the laboratory were used for the collection of soil samples to be analysed for VOCs.	Glass vials supplied by the laboratory were used for the collection of samples to be analysed for VOCs. Samples to be analysed for lower volatility compounds were stored in laboratory-prepared glass jars.
Preservation	Soil and groundwater sample containers were filled to minimise headspace prior to sealing and stored at a low temperature within cool boxes with cooling aids to minimise the loss of volatile contaminants and reduce microbial activity during the collection of samples.	
Sample Integrity	**Soil**	**Groundwater**
	Dedicated disposable nitrile gloves were worn and changed between sample collections to prevent cross-contamination.	Groundwater samples were collected using dedicated plastic tubing, which was changed between monitoring well locations to prevent cross-contamination.
Transport	Samples were stored and shipped in dedicated sample boxes provided by the laboratory. Sample details were recorded on the laboratory chain of custody form enclosed with the samples prior to dispatch. Scheduling information for the samples was confirmed with the laboratory via email.	

Chemical analysis has been undertaken by an accredited laboratory with the testing results summarised and discussed in Section 10 and the testing certificates included in APPENDIX VIII.

Geotechnical samples were collected as required per location immediately after excavation, labelled and sealed to minimise moisture loss. The geotechnical samples were collected and couriered by a dedicated courier to an accredited geotechnical testing laboratory. The testing results are summarised and discussed in Section 9 and the testing certificates are included in APPENDIX IX.

9. GROUND AND GROUNDWATER CONDITIONS

9.1. SUMMARY OF GROUND CONDITIONS

The ground investigation identifies the strata set out in Table 20.

Table 20 Summary of Strata

HOLE	DEPTH TO STRATUM (m BGL)			
	HARDSTANDING	MADE GROUND	CLAY	SAND
TP101	-	0.0-1.4	1.4-2.0	-
TP102	0.0-0.2	0.2-2.1	2.1-2.6	-
TP103	0.1-0.3	0.0-0.1 0.3-2.0	2.0-2.70	-
TP104	-	0.0-0.6	-	-
TP105	-	0.0-1.3	1.3-2.7	-
TP106	0.0-0.2	0.2-0.7	0.7-2.1	-
TP107	0.0-0.6	0.6-2.2	2.2-2.9	-
TP108	0.0-0.2	0.2-2.5	2.5-3.0	-
TP109	0.2-0.3	0.0-0.2 0.3-0.8	0.8-1.2	1.2-1.7
TP110	-	0.0-2.3	2.3-3.2	-
TP111	0.0-0.2	0.2-1.7	1.7-2.2	-
TP112	0.0-0.2	02-0.4	0.4-2.2	-
TP113	0.0-0.1	01-2.2	-	-
TP114	-	0.0-3.1	3.1-3.4	-
WS101	-	0.0-0.8	0.8-1.8	1.8-5.45
WS102	0.0-0.2	0.2-2.3	2.3-4.0	4.0-5.45
WS103	-	0.0-1.0	1.0-3.8	3.8-5.45
WS104	-	0.0-4.5	-	4.5-5.45
WS105	0.0-0.2	0.2-2.5	2.5-4.6	4.6-5.45
WS106	0.0-0.2	-	0.2-2.5	2.5-5.45
CP101	0.0-0.1	0.1-1.2	1.2-2.1 7.1-8.2	2.1-7.1 8.2-9.74
CP102	0.0-1.2	1.2-2.5	2.5-3.7	3.7-9.74
CP103	-	0.0-1.8	1.8-2.7 5.5-6.0	2.7-5.5 6.0-9.76

9.2. MADE GROUND

Made Ground deposits were encountered within all but one (WS106) location to depths ranging between 0.6 m bgl (TP104) and 4.5 m bgl (WS104). The thinnest Made Ground was encountered at the eastern (average 0.98 m) and western edges (average 0.85 m) of the site with thicker Made Ground through the centre (average 1.98 m). The deepest Made Ground appears to be in the southwest of the site where a thickness of 4.5 m (WS104) and 3.1 m (TP114) were recorded. TP104 and TP113 were not able to penetrate the Made Ground due to refusal on obstructions.

Made Ground deposits are variable but in general comprise blackish-brown gravelly fine to medium sand. The gravel fragments comprise concrete, brick, asphalt, ceramic, clinker and slate. Locally, pieces of glass, rebar and electrical wiring were also encountered along with inclusions of ash. Cobbles-sized fragments comprised brick and concrete.

A Depth of Made Ground Plan is presented as Drawing 17-548-006 in APPENDIX IV.

9.3. DRIFT DEPOSITS

Drift deposits were encountered in all locations and typically comprise firm to stiff CLAY overlying fine to medium loose to medium dense SAND. Soft CLAY was encountered in TP110 below the Made Ground at 2.5 m bgl but this was recorded to become firm by 3.0 m bgl.

In the deeper cable percussion boreholes CP101 and CP103 a deeper horizon of gravelly CLAY was recorded at depths of between 7.1–8.2 m bgl and 5.5–6.0 m bgl respectively. The deeper SAND horizons were recorded to become very dense from ca. 7.0 m bgl.

9.4. SOLID GEOLOGY

Solid strata were not recorded during this phase of ground investigation and there are no BGS records within proximity of the site to determine a likely depth.

9.5. GROUNDWATER

Groundwater strikes were encountered as seepages. The depth of the seepages are shown on the exploratory hole records in APPENDIX VII and are summarised in Table 21.

Table 21 Summary of Groundwater Strikes

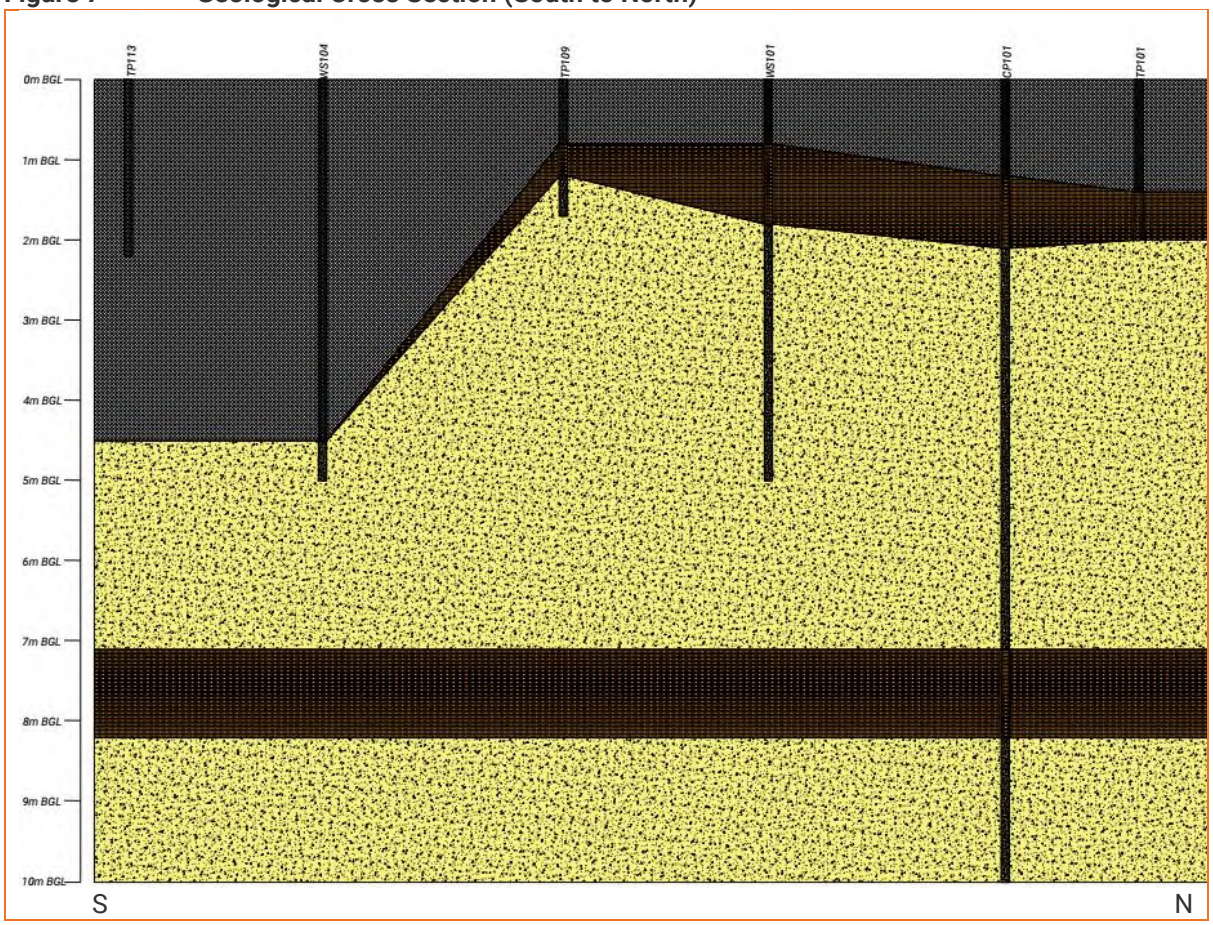
LOCATION	DEPTH TO STRIKE (m)	NOTES
WS101	3.8	Slow ingress
WS102	3.0	Slow ingress
WS104	4.0	Slow ingress
WS106	3.7	Slow ingress
CP101	6.0	Slow ingress
CP102	5.0	Slow ingress
CP103	2.7	Slow ingress
TP105	1.3	Slow ingress

Monitoring was undertaken using an electronic dip meter and interface probe to record the depth to groundwater and the thickness of any free-phase hydrocarbon product, if present. These results are summarised in Table 31.

9.6. GEOLOGICAL CROSS SECTION

A geological cross-section is included shown below in Figure 7.

Figure 7 Geological Cross Section (South to North)



9.7. VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

Visual and olfactory evidence of potential contamination has been identified during the site investigation and these are summarised in Table 22. No free-phase hydrocarbons were observed during drilling.

Table 22 Summary of Visual and Olfactory Evidence of Contamination

LOCATION	DEPTH (m)	STRATUM	NOTES
TP101	0.0-1.4	Made Ground	Slight hydrocarbon odours
TP102	2.1	Made Ground	Slight hydrocarbon odours
TP109	0.3-0.8	Made Ground	Slight hydrocarbon odours
TP114	0.2-3.1	Made Ground	Slight hydrocarbon odours
WS104	4.0-4.5	Made Ground	Slight hydrocarbon odours

9.8. OBSTRUCTIONS

Obstructions and relict substructures were identified in several locations across the site, with their positions summarised in Table 23.

Table 23 Summary of Obstructions

LOCATION	DEPTH (m)	STRATUM	NOTES
TP103	0.4-1.8	Made Ground	Relict brick wall
TP104	0.6	Made Ground	Concrete slab
TP105	0.7-1.2	Made Ground	Relict brick wall
TP108	0.3-2.2	Made Ground	Relict brick wall
TP110	0.5-1.7 0.6	Made Ground Made Ground	Relict brick wall Concrete pipe
TP111	0.8	Made Ground	Boulder of concrete
TP114	3.1	Made Ground	Concrete

10. TIER 2 QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 2 qualitative land risk assessment with respect to human health, controlled waters and ground gas to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

10.1. DEVIATING SAMPLES

Best practice sampling procedures including the use of appropriate sampling containers and adhering to the laboratory holding times for each contaminant analysis, were undertaken in order to avoid samples being deviating.

10.2. SAMPLE ANALYSIS POPULATION

Table 24 summarises the chemical analysis testing scheduled.

Table 24 Summary of Testing Schedule

TYPE OF SAMPLE	NO. OF SAMPLES	DETERMINANDS
Made Ground	9	Metals, Asbestos, General inorganics, Total phenol, PAH, Ali/Aro TPH, VOC
Natural	3	Metals, Asbestos, General inorganics, Total phenol, PAH, Ali/Aro TPH, VOC
Leachate – Made Ground	3	Metals, PAH, phenol, Ali/Aro TPH, BTEX, pH, Cyanide
Groundwater	1	Metals, PAH, phenol, Ali/Aro TPH, BTEX, pH, Cyanide

10.3. HUMAN HEALTH RISK ASSESSMENT

At the Tier 2 stage, the long-term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published in LQM/CIEH S4UL (S4UL3267).

Where Tier 2 screening values are not provided by LQM, other screening values have been used and these are referenced in Table 25.

The Tier 2 screening values for residential with plant uptake have been utilised for this assessment due to the proposed development being a residential end-use. To remain conservative at an early stage, the screening values based on a 1% SOM have been utilised for this assessment.

The results of the comparison have been summarised in Table 25.

Table 25 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use (with plant uptake)

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PL	ASSESSMENT
Arsenic	mg/kg	37	12	130 190 65 49 55 62 46 52	WS102-1.5 WS103-0.3 WS104-1.5 TP102-1.5 TP103-1.0 TP108-2.2 TP111-0.8 TP114-1.5	1	Further Action
Cadmium	mg/kg	11	12	5.5	-	1	No Further Action
Chromium (VI)	mg/kg	6.0	12	<1.8	-	1	No Further Action
Lead	mg/kg	200**	12	560 660 960 220 390 370 2100 1200	WS102-1.5 WS103-0.3 WS104-1.5 TP102-1.5 TP103-1.0 TP108-2.2 TP111-0.8 TP114-1.5	1	Further Action
Mercury	mg/kg	1.2	12	0.9	-	4	No Further Action
Nickel	mg/kg	130	12	100	-	1	No Further Action
Selenium	mg/kg	250	12	<1.0	-	1	No Further Action
Copper	mg/kg	2400	12	1300	-	1	No Further Action
Zinc	mg/kg	3700	12	4800	TP114-1.5	1	Further Action
Cyanide – Total	mg/kg	791	12	16	-	1	No Further Action
Phenols – Total	mg/kg	120	12	<1.0	-	1	No Further Action
Asbestos	Fibres	NFD	12	0.033%	WS104-1.5	3	Further Action
Naphthalene	mg/kg	2.3	12	0.47	-	4	No Further Action
Acenaphthylene	mg/kg	170	12	0.41	-	2	No Further Action
Acenaphthene	mg/kg	210	12	1.6	-	1	No Further Action
Fluorene	mg/kg	170	12	1.3	-	1	No Further Action
Phenanthrene	mg/kg	95	12	14	-	2	No Further Action
Anthracene	mg/kg	2400	12	3.3	-	2	No Further Action
Fluoranthene	mg/kg	280	12	16	-	2	No Further Action
Pyrene	mg/kg	620	12	16	-	2	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	12	6.6	-	2	No Further Action
Chrysene	mg/kg	15	12	7	-	2	No Further Action
Benzo(b)Fluoranthene	mg/kg	2.6	12	7	TP102-1.5	2	Further Action
Benzo(k)Fluoranthene	mg/kg	77	12	2.7	-	2	No Further Action
Benzo(a)Pyrene	mg/kg	2.2	12	2.9 6.6 5	WS104-1.5 TP102-1.5 TP111-0.8	2	Further Action
Indeno(123-cd)Pyrene	mg/kg	27	12	3.1	-	2	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	0.24	12	0.42 0.86 0.69	WS104-1.5 TP102-1.5 TP111-0.8	2	Further Action
Benzo(ghi)Perylene	mg/kg	320	12	3.8	-	2	No Further Action
TPH C5-C6 (aliphatic)*	mg/kg	42	2	<1.0	-	4	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	100	2	<0.1	-	4	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	27	2	<1.0	-	4	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	74	2	<2.0	-	4	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	140	2	<4.0	-	4	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	260	2	42	-	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	1100	2	140	-	1	No Further Action
TPH C5-C6 (aliphatic)	mg/kg	42	10	<0.02	-	1	No Further Action

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX	PL	ASSESSMENT
TPH C6-C8 (aliphatic)	mg/kg	100	10	<0.02	-	4	No Further Action
TPH C8-C10 (aliphatic)	mg/kg	27	10	<0.05	-	4	No Further Action
TPH C10-C12 (aliphatic)	mg/kg	74	10	<1.0	-	4	No Further Action
TPH C12-C16 (aliphatic)	mg/kg	140	10	<2.0	-	4	No Further Action
TPH C16-21 (aliphatic)	mg/kg	260	10	3.3	-	1	No Further Action
TPH C21-C35 (aliphatic)	mg/kg	1100	10	200	-	1	No Further Action
TPH C5-C7 (aromatic)	mg/kg	70	10	<0.01	-	4	No Further Action
TPH C7-C8 (aromatic)	mg/kg	130	10	<0.01	-	4	No Further Action
TPH C8-C10 (aromatic)	mg/kg	34	10	<0.05	-	4	No Further Action
TPH C10-C12 (aromatic)	mg/kg	74	10	2.0	-	4	No Further Action
TPH C12-C16 (aromatic)	mg/kg	140	10	8.5	-	4	No Further Action
TPH C16-C21 (aromatic)	mg/kg	260	10	38	-	1	No Further Action
TPH C21-C35 (aromatic)	mg/kg	1100	10	270	-	1	No Further Action

Notes
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = Vapour/Gas Inhalation

Abbreviations: GAC = general assessment criteria, N = number of samples, MC = maximum concentration; Loc of Ex = location of exceedance; PL = Contaminant Pathway; NFD = no fibres detected.

The pathway noted in the table is the primary pathway, however it may not be the only pathway of that contaminant
* The Tier 2 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 2 values for aliphatic compounds for the volatile and semi volatile fractions (C5-C12) and the Tier 2 values for aromatic compound for the non-volatile fractions (C12-C35). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.
**The Tier 2 GAC for lead has been taken from CL:AIRE C4SL.

Referring to Table 25, the results of this direct comparison indicate that the data exceeds the screening criteria for residential end-use for the following contaminants:

Inorganics

- Aresenic-PL1
- Lead-PL1
- Zinc-PL1
- Asbestos-PL3

Organics

- Benzo(b)Fluoranthene-PL2
- Benzo(a)Pyrene-PL2
- Dibenzo(a,h)Anthracene -PL2

10.3.1. EXPOSURE PATHWAYS

The main exposure pathways based on the Tier 2 exceedances are:

- Soil ingestion (PL1);
- Dermal contact and ingestion (PL2);
- Consumption of homegrown vegetables (PL1); and
- Fibre/dust inhalation (PL3).

10.3.2. HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

Inorganic Heavy Metals

All of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils (PL2), inhalation of particulate (PL3) and consumption of homegrown vegetables (PL1). The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private gardens, landscaping and public open space to remove any potential for direct exposure to impacted soils.

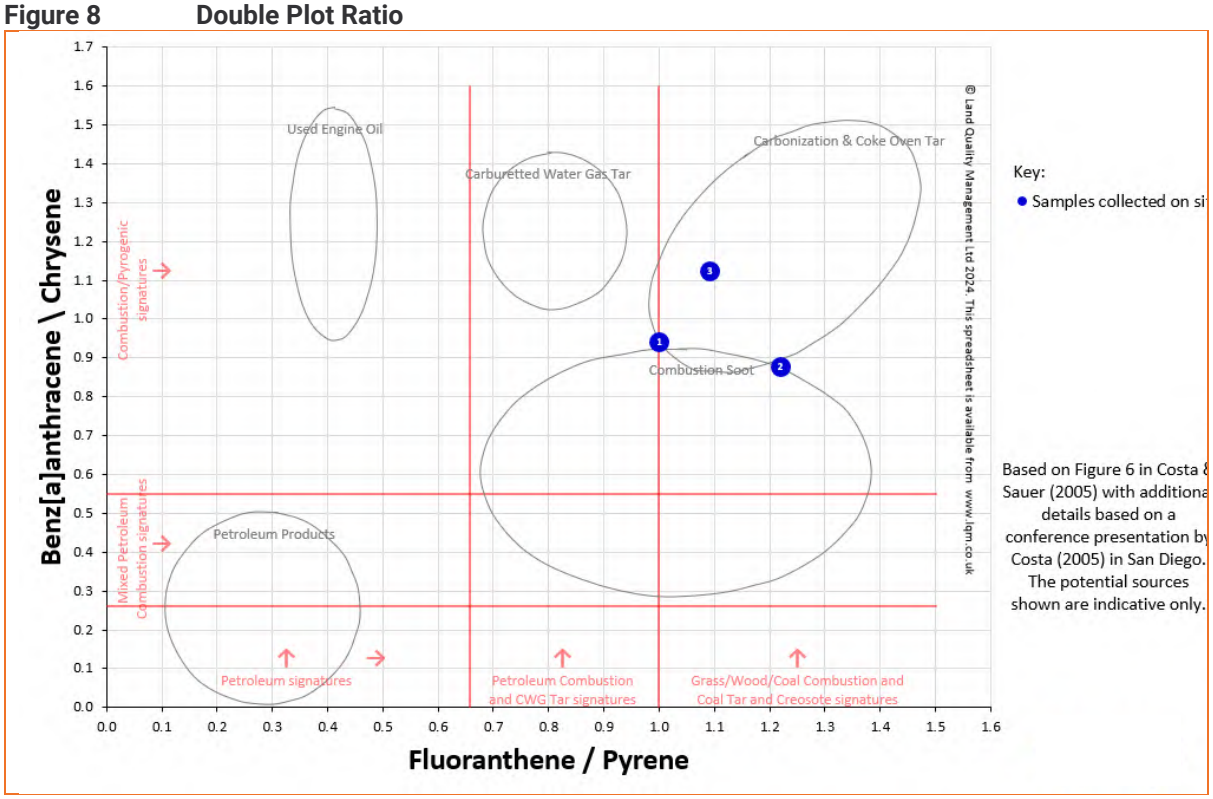
The specific design and installation process for the appropriate cover systems will be clearly defined within the site remediation and enabling works strategy.

PAH Double Plot Ratio

Based on the elevated PAHs identified within the soils, the PAH double ratio tool (based on work by Costa & Sauer 2005) has been utilised for the samples where exceedances have been recorded to enable a quick assessment of the potential source of PAH within the soil samples.

Figure 8 includes a snapshot of the double plot ratio for the PAH impacted soils in question.

Figure 8 Double Plot Ratio



The double plot ratio indicates that the recorded PAH in samples from TP102 and WS104 are a result of combustion soot with ash noted in the soil descriptions. The sample from TP111 may be a result of carbonization with the soil description noting the presence of asphalt which may be the source. It should therefore be considered that other exceedances of these PAH compounds may be recorded in locations where ash and asphalt are noted.

Asbestos

Asbestos in the form of loose chrysotile fibres has been identified in the granular Made Ground in WS104. The concentration recorded was 0.033%.

No visual signs of ACM were encountered during the ground investigation; it is, therefore, likely that only trace fibres are present. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 9.

Figure 9 Asbestos Risk Mitigation Conceptual Site Model



Notes
ND None Detect
0.001% Soils may contain ≤ 0.001% asbestos using composite testing to ensure there is no potential risk to human health. This value is present within areas where there may be a short term low level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (dust suppression)
0.1% Soils at a depth of >1.00m bgl may contain <0.1% asbestos using composite testing where they will not be likely to be disturbed in the future and will therefore be in an area of low sensitivity. Risk assessment completed in accordance with Asbestos JIWG risk assessment tools.
Undefined- this will be dependent upon soils encountered during earthworks, which may be placed at these depths to ensure no potential risk to human health.

Chemical analysis of the natural clay drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical validation samples may be required to meet regulatory sampling frequency. There are no suitable sources of topsoil available on the site.

10.4. CONTROLLED WATERS RISK ASSESSMENT

E3P has undertaken a controlled waters risk assessment for the site based on the consideration of the conceptual site model and the sensitive receptors which are summarised in Table 26.

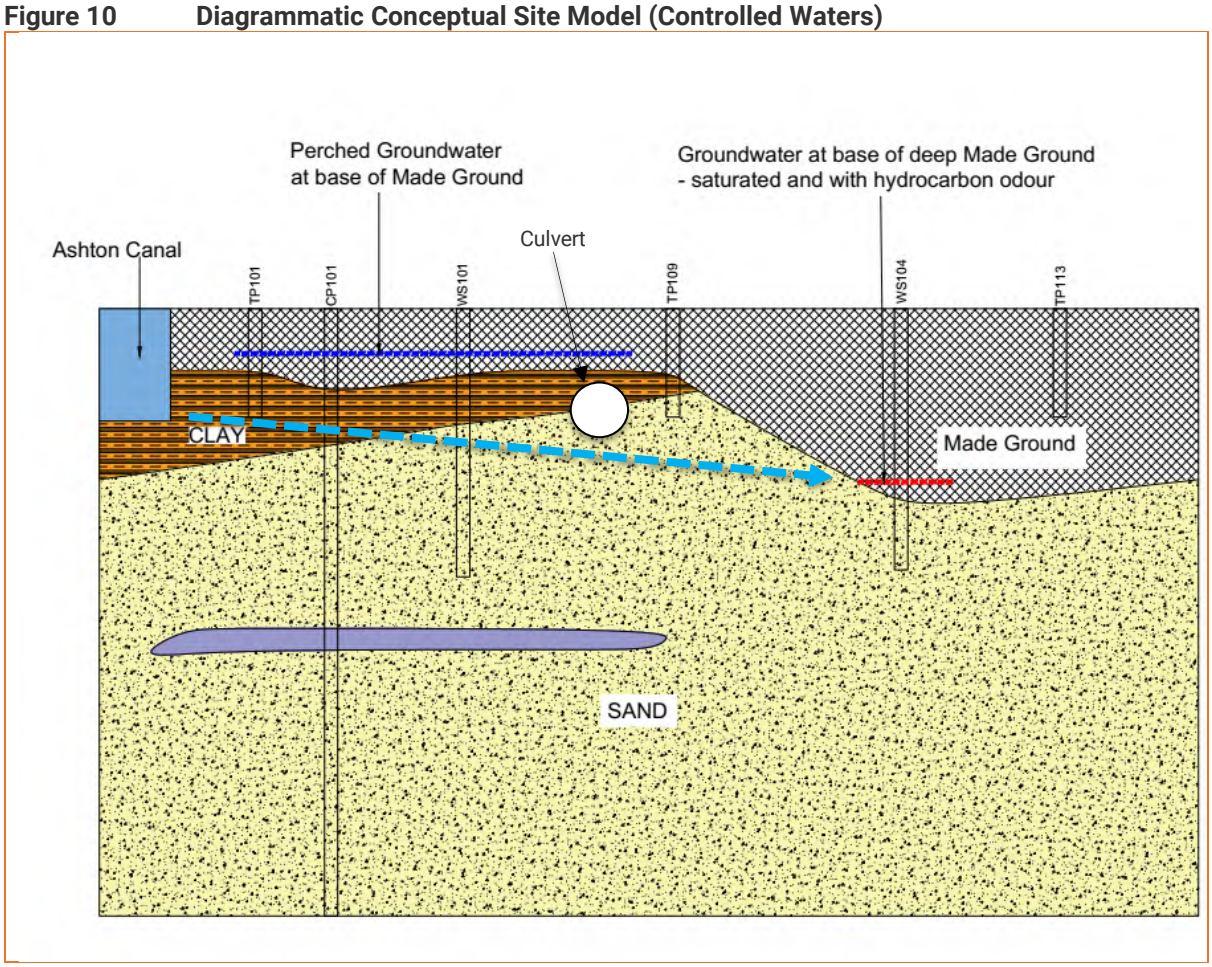
Table 26 Controlled Waters Conceptual Model and Sensitivity Profile

DISCUSSION		SENSITIVITY RATING
Contaminant Source		
The site has historically been an iron foundry and packaging works with an area of suspected landfilling encroaching onto the southern sector of the site. Made Grund deposits at the site have been recorded in all but one location with the thickest deposits being recorded in the southwest which may correspond with the area of the historical landfill. Within the Made Ground, fragments of clinker, metal and asphalt have been recorded and soil analysis has recorded elevated concentrations of arsenic, lead and PAH compounds when compared with human health screening criteria. These determinands would not typically be considered as significantly mobile. Slight hydrocarbon odours were noted within the Made Ground but no elevated concentrations of TPH or VOC were identified in the subsequent analysis.		**Medium**
Pathway		
Vertical Migration The exploration has identified that there is an upper clay horizon to the drift across the majority of the site which will afford some protection to the underlying granular drift deposits. This is however absent in the area where the Made Ground is deepest (WS104). Further deeper clay horizons have been identified in the cable percussion boreholes CP101 and CP103 but not in CP102.		**Medium**
Lateral migration Lateral migration of contaminants is considered possible due to the presence of granular drift deposits across the site.		**Medium**
Receptor		
Aquifer Classification in Superficial Drift Deposits	Undifferentiated – Glacial Till - Clay Secondary B aquifer – Fluvoglacial - Sand	**Medium**
Aquifer Classification in Bedrock	Secondary B aquifer – Manchester Marl	**Medium**
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not affected.	**Low**
Distance to the Closest Groundwater Abstraction Point	687 m west – Evaporative Cooling. Aquifer is the Chester Formation	**Low**
Is the Site Located Within 50 m of a Surface Watercourse?	Ashton Canal is located at the northern boundary. However, this is not considered to be a sensitivity receptor as it is a lined artificial channel. The canal will be ca. 2.0 m deep and groundwater monitoring has confirmed that groundwater is at a greater depth in the south; below the base of the canal (3.68 m bgl – WS104). This would indicate a gradient away from the canal and provides evidence that the canal is not in continuity with groundwater.	**Medium**

DISCUSSION		SENSITIVITY RATING
	Historical maps identify a culvert on site on the earliest maps but its presence was not confirmed on-site. If present, this will likely flow through a brick or concrete duct which will afford some protection from shallow groundwater infiltration and the culvert will also be of low ecological value.	
The ICSM developed within the context of the site setting has identified viable pollutant pathways, which would be the downward migration of potentially mobile phase-soluble contaminants towards the underlying secondary B aquifer and lateral migration to the adjacent canal.		

In addition to above, E3P has developed a diagrammatic conceptual model which considers the factors in Table 26. This is included in Figure 10.

Figure 10 Diagrammatic Conceptual Site Model (Controlled Waters)



The Tier 2 assessment in line with LCRM (2023) has included a comparison of leachate analysis from samples of the Made Ground and groundwater samples to drinking water standards (DWS) and environmental quality standards (EQS).

DWS will be viewed as a priority given the pollutant linkage is considered to be vertical migration to the secondary B aquifer, however where there are no regulatory guidance values for EQS, the DWS will be utilised in their absence.

Limited groundwater was recorded during subsequent monitoring, with only one sample collected for subsequent analysis. The result is still awaited and will be reported in due course.

Leachate samples were selected on the basis that they represented typical Made Ground at the site and included potentially contaminating material such as clinker, ash and hydrocarbon odours, thereby representing a likely worst-case.

A single water sample was obtained utilising a bailer but this result is not yet available.

These are presented in Table 27.

Table 27 Comparison of Groundwater and Leachate Analysis with Tier 2 Screening Levels

DETERMINAND	UNIT	EQS [1, 2] AA	DWS [3,4]	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
Arsenic	µg/l	50	10	1	1.1	-	3	15	DWS	Further Action
Cadmium	µg/l	0.08-0.25	5	1	<0.11	-	3	<0.08	-	No Further Action
Chromium (VI)	µg/l	3.4	–	1	<20	-	3	57	EQS	Further Action
Chromium (III)	µg/l	4.7	50	1	<0.50	-	3	60	DWS/EQS	Further Action
Copper	µg/l	1	2000	1	3.8	-	3	22	-	No Further Action
Total Cyanide	µg/l	1	50	1	<0.005	-	3	6.6	EQS	Further Action
Lead	µg/l	1.2	10	1	0.63	-	3	18	DWS/EQS	Further Action
Mercury	µg/l	–	1.0	1	<0.001	-	3	<0.5	-	No Further Action
Nickel	µg/l	4	20	1	2.9	-	3	2.6	-	No Further Action
Selenium	µg/l	–	10	1	<0.5	-	3	<4.0	-	No Further Action
Zinc	µg/l	10.9	–	1	4.5	-	3	18	EQS	Further Action
pH	6–9			1	7.3	-	3	7.8-7.9	-	No Further Action
Polycyclic Aromatic Hydrocarbon										
Naphthalene	µg/l	2	10*	1	<0.5	-	3	<0.01	-	No Further Action
Anthracene	µg/l	0.1	10*	1	<0.5	-	3	<0.01	-	No Further Action
Benzo[b]fluoranthene	µg/l	0.00017*	10*	1	<0.5	-	3	<0.01	-	No Further Action
Benzo[k]fluoranthene	µg/l	0.00017*	10*	1	<0.5	-	3	<0.01	-	No Further Action
Benzo(a)pyrene	µg/l	0.00017*	10*	1	<0.5	-	3	<0.01	-	No Further Action
Indeno(123-cd)pyrene	µg/l	0.00017*	10*	1	<0.5	-	3	<0.01	-	No Further Action
Fluoranthene	µg/l	0.0063	10*	1	<0.5	-	3	<0.01	-	No Further Action
Benzo(ghi)perylene	µg/l	1.7–4	10*	1	<0.5	-	3	<0.01	-	No Further Action
Aromatic Hydrocarbon										
TPH C5-C7 (benzene)	µg/l	10	1	1	<0.1	-	3	<1.0	-	No Further Action
TPH C7-C8 (toluene)	µg/l	74	700	1	<0.1	-	3	<1.0	-	No Further Action
TPH C8-C10 (xylene)	µg/l	30	300	1	<0.1	-	3	<1.0	-	No Further Action
TPH C10-C12 (naphthalene)	µg/l	2	90	1	<0.1	-	3	<10	-	No Further Action

DETERMINAND	UNIT	EQS [1, 2] AA	DWS [3,4]	NO. OF GW SAMPLES	MAX CONC. IN GROUNDWATER	LOCATION OF EXCEEDANCE	NO. OF LEACHATE SAMPLES	MAX CONC. IN LEACHATE	LOCATION OF EXCEEDANCE	ASSESSMENT
TPH C12-C16	µg/l	–	90	1	<0.1	-	3	<10	-	No Further Action
TPH C16-C35	µg/l	–	90	1	<0.1	-	3	<10	-	No Further Action
Aliphatic Hydrocarbon										
TPH C5-C6	µg/l	–	1000[5]	1	<0.1	-	3	<1.0	-	No Further Action
TPH C6-C8	µg/l	–	1000[5]	1	<0.1	-	3	<1.0	-	No Further Action
TPH C8-C10	µg/l	–	300	1	<0.1	-	3	<1.0	-	No Further Action
TPH C10-C12	µg/l	–	300	1	<0.1	-	3	<10	-	No Further Action
TPH C12-C16	µg/l	–	300	1	<0.1	-	3	<10	-	No Further Action
TPH C16-C21	µg/l	–	300**	1	<0.1	-	3	<10	-	No Further Action
TPH C21-C35	µg/l	–	300**	1	<0.1	-	3	<10	-	No Further Action
Volatile Organic Compounds										
Benzene	µg/l	10	1	1	<0.1	-	3	<3	-	No Further Action
Toluene	µg/l	74	700	1	<0.1	-	3	<3	-	No Further Action
Xylene	µg/l	30	300	1	<0.1	-	3	<3	-	No Further Action

Notes
 # Solubility <0.01µg/l
AA – Annual Average
** Polyaromatic hydrocarbons (PAH) - Benzo(a)pyrene (BaP), Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water*
*** There are no WHO Guideline Values for aliphatic fractions C16-C21 and C21-C35, therefore the guideline value for aliphatic fractions inclusive of C8-C16 (300µg/l) has been applied.*

1. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (legislation.gov.uk)
2. The Water Supply (Water Quality) Regulations 2018 (legislation.gov.uk)
3. Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum (who.int)
4. CL:AIRE publishes Petroleum Hydrocarbons in Groundwater guidance (claire.co.uk)
5. *A total TPH criteria of 1000 mg/kg will act as a surrogate criterion for remaining aliphatic and aromatic TPH fractions.*

10.4.1. CONTROLLED WATER RISK ASSESSMENT AND MITIGATION

This comparison indicates that the data exceeds the EQS and DWS values for the following inorganic compounds:

Table 28 Summary of Controlled Waters Risk Assessment

EXCEEDANCE OF EQS	EXCEEDANCE OF DWS
Chromium VI	Arsenic
Total Chromium (as Cr III)	Total Chromium
Total Cyanide	Lead
Lead	
Zinc	

Although widespread observations of hydrocarbon odours were noted throughout the site, both soil analysis and leachate testing have not identified significantly elevated concentrations of PAH and TPH.

In line with soil analysis, the leachate testing has also recorded elevated arsenic and lead when compared to the DWS. Elevated chromium and hexavalent chromium have also been recorded in the leachate tests.

The leachate test is aggressive (de-ionised water) and is not in aqueous equilibrium (steady state) within the solid sample. This may cause rapid dissolution and overestimation of the aqueous phase concentrations compared to groundwater in contact with contaminated soils. Although dissolution may be reduced for highly hydrophobic contaminants, such as B(a)P the initial leaching will likely remove the most readily available hydrocarbons and subsequent flushing would reduce the leachable concentrations.

10.4.2. M-BAT ASSESSMENT

Although the Ashton Canal is not considered a main receptor in view that the channel will be lined, due to exceedances in leachate samples for zinc in all three samples, an m-BAT assessment has been completed to assess the bioavailability of the metals with respect to surface water receptors (Ashton Canal). The chemical values from the groundwater analysis have been input into the assessment.

Where the Risk Characterisation Ratio (RCR) is greater than 1, this indicates the bioavailable concentration is above the EQS and the receptor is therefore at risk.

1. WS102
    - Zinc - 0.21
2. WS103
    - Zinc - 0.16
3. WS104
    - Zinc - 0.20

The m-BAT assessment has confirmed that the RCR for zinc is below 1, indicating that is it not bioaccessible and therefore unlikely to be a risk.

10.4.3. FINAL PB SCREENING TOOL

Lead was recorded in two of the leachate samples in excess of the EQS value. To further assess the potential risk, an assessment using the Pb screening tool has been completed.

The assessment confirms that the following

- WS102 – 0.75
- WS104 – 0.08

As the RCR is below 1, E3P does not consider lead to pose an unacceptable level of risk to surface waters for lead.

10.4.4. DISCUSSION OF CONTROLLED WATERS RISK ASSESSMENT

Historically, the site comprised an iron foundry, packaging works with evidence of possible landfilling the south of the site.

The site is underlain by Made Ground which in turn is underlain by a clay horizon across much of the site except for the southwest of the site (WS104). The clay and Made Ground at WS104 are underlain by sand, the full thickness of which was not proven during this phase of investigation.

Groundwater strikes were recorded as slow ingress in the window sample probeholes but monitoring wells installed to their full depth (ca. 5 m bgl) did not generate significant groundwater for subsequent sampling except for WS103 in the northeast.

Widespread arsenic, lead and PAH impact has been identified in the soil, with leachate testing indicating potentially mobile impact from arsenic, lead and zinc.

The groundwater beneath the site is likely at depth and based on the site setting is not considered a highly sensitive receptor being a secondary B aquifer and with no groundwater abstraction within the drift. A groundwater abstraction is identified ca. 650 m to the west but this is for evaporative cooling and is likely abstracting from the Chester Formation Sandstone and not the Manchester Marl which underlies the subject site.

A foundation design has not been determined but it is likely that for the majority of low-rise plots, these can found in underlying clay or re-engineered Made Ground using vibro-replacement stone columns. Either option would not generate any new preferential vertical pathways.

For the high-rise plots, it is likely that a piled foundation would be required and a pile design contamination risk assessment will be required once the type of pile has been determined. However, it is considered that penetrative piling techniques would not create significant vertical pathways is located in the north of the site where extensive Made Ground has not been identified.

Surface Water Receptor

As the m-BAT and Pb screening tools have confirmed, the surface water receptor, the Ashton Canal, is not at risk from lead and zinc. It is also considered that due to the depth of groundwater recorded in the on-site monitoring wells, the canal is not in hydraulic continuity groundwater. Sampling of the canal may assist in determining if the canal is at risk.

The historical culvert has not been identified on-site and if present is likely to be set within a brick or concrete culvert and and low ecological value. Further survey work is recommended to try and determine if this feature is still present and if so its current condition.

E3P consider the underlying granular drift aquifer as the critical receptor.

10.5. GROUND GAS RISK ASSESSMENT

10.5.1. RATIONALE

Hazardous ground gas qualitative risk assessment is based on a conceptual site model (CSM) similar to that used for soil and groundwater contamination sources (i.e., source pathway receptor pollutant linkages).

The risk can be assessed based on knowledge of the ground conditions and CSM and a measure of hazardous gas concentrations and gas flow at the site within monitoring standpipes.

10.5.2. SOURCES AND PATHWAYS OF GROUND GAS

Table 29 summarises the potential sources and pathways of ground gas within the context of the recorded site setting and proposed development.

Table 29 Identified Potential Sources of Ground Gas

SOURCE
Made Ground Made Ground deposits were encountered within all but one (WS106) location to depths ranging between 0.6 m bgl (TP104) and 4.5 m bgl (WS104). The thinnest Made Ground was encountered at the eastern (average 0.98 m) and western edges (average 0.85 m) of the site with thicker Made Ground through the centre (average 1.98 m). the deepest Made Ground appears to be in the southwest of the site where thicknesses of 4.5 m (WS104) and 3.1 m (TP114) were recorded. Made Ground deposits are variable but in general comprise blackish-brown gravelly fine to medium sand. The gravel fragments comprise concrete, brick, asphalt, ceramic, clinker and slate. Locally, pieces of glass, rebar and electrical wiring were also encountered along with inclusions of ash. Cobbles-sized fragments comprised brick and concrete.
Drift Strata Drift deposits were encountered in all locations and typically comprise firm to stiff CLAY overlying fine to medium loose to medium dense SAND. Soft CLAY was encountered in TP110 below the Made Ground at 2.5 m bgl but this was recorded to become firm by 3.0 m bgl. In the deeper cable percussion boreholes CP101 and CP103 a deeper horizon of gravelly CLAY was recorded at depths of between 7.1-8.2 m bgl and 5.5-6.0 m bgl respectively. The deeper SAND horizons were recorded to become very dense from ca. 7.0 m bgl.
Solid Strata The site is underlain by Manchester Marl and although located within a Coal Mining Reporting Area no seams or shafts have been identified within 1 km of the site and associated coal will be at a significant depth.
Landfill Sites Groundsure data indicates that there is one historical landfill that is located principally on land to the south of the subject site but which may extend into the southern sector. Exploration has identified Made Ground in this sector to 4.5 m bgl. The landfill site has no historical or current environmental permits. Records suggest that this site accepted inert industrial wastes between ca. 1942 and 1992 and pre-dated licencing requirements.
Other Gases The BGS reports that full radon protective measures are not necessary in the construction of new dwellings or extensions. Volatile organic compounds and volatile PAH and TPH compounds have not be recorded at the site..

The CIRIA C665 guidance on gas risk assessment includes recommendations for periods and frequencies for monitoring visits. These recommendations take into account the nature of the proposed development and the likely generation potential of the source.

The proposed development comprises private residential properties, which would be classified as a Type A development (high sensitivity) in accordance with BS8485:2015+A1:2019. However, it is considered that the likely generation potential of the identified gas sources (taking into account the likelihood of future increases in gas generation) would be best classified as low.

Therefore within the context of the proposed residential end-use and ground gas generation potential, the gas assessment requires six visits over three months, with at least two sets of readings at low or falling atmospheric pressure.

10.5.3. GROUND GAS RISK ASSESSMENT METHODOLOGY

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in:

- CIRIA Report 665 – Assessing risks posed by hazardous ground gases to buildings (2007)
- BS8485:2015+A1:2019 – Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation (CS) and the proposed development based on building type.

Therefore, in accordance with BS8485, based on the measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) shall be derived for each monitoring point, from which the site characteristic hazardous gas flow rate (Q_{hgs}), and then the Characteristic Situation (CS) can be determined.

The following equation should be utilised:

$$Q_{hg} = q\left(\frac{C_{hg}}{100}\right)$$

Where:
q is the measured flow rate (in litres per hour) of combined gases from the monitoring standpipe
C_{hg} is the measured hazardous gas concentration (in percentage volume/volume).

The subsequent derived gas screening value (GSV) should be the maximum Q_{hg} (flow rate x concentration as a percentage volume) for all the monitoring events.

A 'worst case check' may be carried out using the maximum recorded flow in any hole with the maximum concentration in any hole to present the plausible worst case conditions. Adoption of the worst case Q_{hg} requires thorough justification and reference to the CSM.

The final derived GSV can then be used to characterise the site as summarised in Table 30.

Table 30 Site Characterisation by GSV (BS8485:2015)

CS	HAZARD POTENTIAL	GSV (L/HR) FOR METHANE AND CARBON DIOXIDE	ADDITIONAL FACTORS
CS1	Very Low	< 0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	< 0.70	Typical measured flow rate <70 l/h (otherwise consider an increase to CS3)
CS3	Moderate	< 3.5	N/A
CS4	Moderate to High	< 15	N/A
CS5	High	< 70	N/A
CS6	Very High	> 70	N/A

Notes

1) *The CS is equivalent to the characteristic GSV in CIRIA C665.*
2) *The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter should be considered.*
3) *Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, multiplied by the concentration in the air stream of the particular gas being considered.*
4) *The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.*

It should be noted that in the first instance, this assessment has been carried out in accordance with BS8485:2015+A1(2019) and the thresholds given in Table 30.

10.5.4. MONITORING METHODOLOGY

Concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) were measured using a calibrated infrared gas analyser (GFM435) with gas flow rates measured using an integrated flow meter.

Gas measurements were recorded for a minimum of 300 seconds (5 minutes) at each location, increasing to 600 seconds if elevated concentrations identified, at which point the maximum concentration of CH_4 and CO_2, together with the lowest concentration of O_2 were recorded.

The results of the ground gas monitoring are presented in Table 31.

In addition to the raw data, the results for each individual standpipe have been assessed with reference to guidance provided in BS8485:2015. Based on the initial peak measured flow rates and hazardous gas concentrations, individual hazardous gas flow rates (Q_{hg}) have been derived for each monitoring point, from which an individual Characteristic Situation (CS) can ultimately be determined.

10.5.5. SUMMARY OF MONITORING RESULTS

Table 31 presents of the ground gas and groundwater monitoring results to date.

Table 31 Summary of Ground Gas Monitoring Results

WELL	STRATA	DATE	CH_4 PEAK (%V/V)	CH_4 STEADY (%V/V)	CH_4 Q_{hg} (l/hr)	CO_2 PEAK (%V/V)	CO_2 STEADY (%V/V)	CO_2 Q_{hg} (l/hr)	O_2 (%V/V)	ATMOS (mb)	ATMOS. DYNAMIC	PEAK FLOW (l/hr)	STEADY FLOW (l/hr)	RESPONSE ZONE (m bgl)	DEPTH TO BASE (m bgl)	DEPTH TO WATER (m bgl)
WS101	Natural	26/03/2024	0.2	0.1	0.0002	4.6	4.6	0.0046	9.9	977	Falling	0.1	0.1	0.5-3.5	3.56	3.55
WS102	Made Ground	26/03/2024	0.1	0.1	0.0001	2.6	2.6	0.0026	15.4	977	Falling	0.1	0.1	0.5-2.0	2.57	2.22
WS103	Natural	26/03/2024	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	976	Falling	0.1	0.1	2.0–4.0	3.25	1.35
WS104	Made Ground	26/03/2024	0.1	0.1	0.0001	0.1	0.1	0.0001	20.3	976	Falling	0.1	0.1	1.0-4.5	4.25	3.68
WS105	Made Ground	26/03/2024	0.1	0.1	0.0001	0.9	0.9	0.0009	19.3	978	Falling	0.1	0.1	1.0-2.5	2.43	Dry
WS106	Natural	26/03/2024	0.1	0.1	0.0001	1.4	1.4	0.0014	16.2	978	Falling	0.1	0.1	2.0-4.0	3.88	3.76

Notes

CIRIA Characteristic Situation Q_{hg}

	CS1	*<0.07*	*Typical Max CO2 <5 % Typical Max CH4 <1 %*
	CS2	*<0.7*	*Flow rate not to exceed 70 l/hr otherwise consider increase to CS3*
	CS3	*<3.5*	
	CS4	*<15*	*Quantitative Risk Assessment required to evaluate scope of protective measures*

Values in BOLD exceed CS1 Thresholds

Values in BLUE denote water above level of response zone (flooded)

10.5.6. GROUNDWATER

The water level within WS103 was recorded to be above the top of the response zone (flooded) on a number of occasions, as summarised in Table 32, thus rendering some the monitoring data unreliable.

Table 32 Flooded Monitoring Well Data

WELL	VISIT 1 26/3/2024	VISIT 2	VISIT 3	VISIT 4	VISIT 5	VISIT 6
WS101	-					
WS102	-					
WS103	Y					
WS104	-					
WS105	-					
WS106	-					

10.5.7. BAROMETRIC PRESSURE

Only one visit has been completed to date and this was completed during a period of low and falling pressure.

10.5.8. GAS FLOW

Gas flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser) in each of the monitoring locations.

10.5.9. GAS CONCENTRATIONS

The maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser).

Carbon dioxide concentrations were recorded at a concentration of 4.6 % v/v (WS101).

10.5.10. RADON RISK

The subject site is not located within an area at risk of radon gas.

10.5.11. CONCLUSION

The determined Characteristic Situation for each standpipe for is presented in Table 33. This indicates that based on the peak flow rates the monitoring visits classify as Characteristic Situation (CS)1 – Very Low Gas Risk.

Table 33 Gas Risk Profile and Location

WELL	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION
WS101	3.56	0.1	0.1	0.0002	4.6	0.0046	CS1
WS102	2.22	0.1	0.1	0.0001	2.6	0.0026	CS1
WS103	1.35	0.1	0.1	0.0004	0.1	0.0001	CS1
WS104	3.68	0.1	0.1	0.0001	0.1	0.0001	CS1
WS105	DRY	0.1	0.1	0.0001	0.9	0.0009	CS1
WS016	3.76	0.1	0.1	0.0001	1.4	0.0014	CS1

The full gas assessment will be reported in due course.

10.6. POTABLE WATER SUPPLY

This section provides a summary of the site investigation data with reference to the selection of potable water supply pipework. The assessment is made with reference to the UK Water Industry Research (UKWIR) publication "Guidance on the selection of Water Supply Pipes to be used in Brownfield Sites"

Table 34 Pipeline Selection PE Threshold Concentrations

CONTAMINANT GROUP	PE-THRESHOLD (mg/kg)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (mg/kg)
Total VOC	0.5	<1.0
Total BTEX And MTBE	0.1	N/A
Total SVOCs (Excluding PAH and those substances marked with an *)	2	N/A
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2	<1.0
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10	3.3
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500	510-WS104
Phenols (From SVOC Analysis)*	2	N/A
Cresols and Chlorinated Phenols (From SVOC Analysis)	2	NA
Ethers*	0.5	NA
Nitrobenzene*	0.5	NA
Ketones*	0.5	NA
Aldehydes*	0.5	NA
Amines	Fail	NA
Other Consideration		
Are there any exceedances of the PE threshold outside of the pipeline depth?	None have been recorded.	
Is free product present in soil and groundwater?	None	
Could hydrocarbon impact at greater depth than current pipeline depth be mobilised by rising groundwater levels?	Unlikely.	
Will soils impacted with above determinands likely be utilised elsewhere on site?	Unknown at this stage	

CONTAMINANT GROUP	PE-THRESHOLD (mg/kg)	CONCENTRATIONS AT CURRENT PIPELINE DEPTH (mg/kg)
Will soils be imported to site as part of any future earth works	Currently unknown.	

Notes - Pipe line depth normally between 0.75m–1.35m

Based on the assessment of current site conditions it is likely that barrier pipe will be required at the proposed development.

10.7. DEVELOPED CONCEPTUAL SITE MODEL

Following the completion of the intrusive site investigation, chemical analysis and risk assessment, the conceptual model shown in Table 35 has been prepared for the site.

Table 35 Developed Conceptual Model

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
SOIL						
		HUMAN HEALTH				
Made Ground Metals (arseni, lead, PAH) –	Accidental ingestion and/or dermal contact with contaminated soil and/or leachate. **PL1/PL2** Inhalation of contaminated dust. **PL3**	Human Health – construction workers Human Health – end users	Likely	High	The CSM has identified contaminants of concern as above assessment criteria. Site personnel have a greater chance of coming into contact with contaminated soils. Particularly during excavation and soil recovery works. **Recommendation:** Construction works are to be completed with appropriate PPE and welfare facilities.	Low
		Human Health – end users	Likely	High	Impacted soils may pose a risk where present in garden and landscaped areas. **Recommendation:** Cover system to garden and landscaped areas will prevent exposure to future site users.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Made Ground Hydrocarbon	Inhalation of vapours. **PL4**	Human Health – end users Human Health – Off-site receptors	Low likelihood	Low	Hydrocarbon odours throughout the Made Ground. However, no elevated concentrations were recorded in the laboratory analysis. **Recommendation:** No further action is required	Very low
Made Ground Asbestos (Asbestos containing materials (ACM) and loose fibres)	Inhalation (of fibres). Construction works disturbing bound material and releasing fibres. **PL3**	Human Health - Site personnel, end land users, and users of adjacent sites	Likely	Medium	One soil sample has identified loose chrysotile fibres at 0.03% v/v. While this would indicate a low risk, further occurrences cannot be entirely discounted **Recommendation:** Cover system to garden and landscaped areas will prevent exposure to future site users. Construction works completed with PPE and provision of welfare.	Low
Made Ground Sulphate from potential ash within the Made Ground.	Sulphate attack on concrete. **PL6**	Building concrete	Low likelihood	Medium	Due to the presence of Made Ground on the Site, elevated sulphate cannot be discounted with a single result indicating a concrete classification of DS3/AC2. The majority of the site is DS1/AC1. **Recommendation:** Construction works to be completed with appropriate PPE and welfare facilities.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
Made Ground Petrolum hydrocarbons	Ingestion of tainted water supply. **PL7**	Human Health – End Users Water pipeline	Likely	Medium	Likely probability as significant contamination identified at pipeline depth across the west of the Site (0.75–1.35 m). **Recommendation:** Barrier pipe is likely to be required following a pipeline risk assessment.	Low
Made Ground Phytotoxic contaminants	Direct contact (plant uptake). **PL8**	Flora	Likely	Medium	Likely probability as contamination considered possible, which may be taken up by flora in soft landscaping/gardens. **Recommendation:** A cover system is recommended for garden and landscaped areas.	Low
CONTROLLED WATERS						
Made Ground Metals	Leaching of metals from Made Ground and infiltration and percolation of rainwater. **PL5**	Controlled waters: Secondary B aquifer Ashton Canal	Low likelihood	Low	Elevated metals have been identified in the Made Ground and leachate analysis has indicated that concentrations in excess of DWS are possible. However, the overall sensitivity of controlled water receptors is reduced due to the absence of any groundwater abstractions and the likelihood that the canal is not in hydraulic continuity with the site.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
					Recommendation: No further works are considered necessary but additional groundwater and surface water monitoring may help to confirm the current assessment.	
Groundwater	Contact with contaminated groundwater. **PL2**	Human Health – site personnel	Unlikely	Low	Groundwater is known to be below construction level and as such, is expected to not rise above ground level or the final level of the road.	Low
	Contaminants leached from the off-site sources. **PL5**	Human Health – end users	Low likelihood	Low	An off-site landfill has been identified to the south. The northern sector of the landfill may have encroached on the southern boundary of the subject site. The landfill may contain elevated concentrations of metals, hydrocarbons and ammonia etc. However, given the topographic gradient, the main body of the landfill is considered to be down-gradient and therefore unlikely to be a risk to on-site controlled waters.	Low
GROUND GAS						
Ground gases (methane and carbon dioxide)	Inhalation of ground gas. **PL4**	Human Health – site personnel	Unlikely	Low	Ground gas assessment is ongoing but initial results indicate that there is no on-site source.	Low

CONTAMINANT RISK			LIKELIHOOD	SEVERITY	MITIGATION DISCUSSION	RESIDUAL RISK
SOURCES	**MIGRATION PATHWAYS**	**RECEPTORS**				
	Accumulation of ground gas in confined spaces (asphyxiation or explosion)	Human Health – end users	Unlikely	Low	Ground gas assessment is ongoing but initial results indicate that there is no on-site source.	Low
		Infrastructure and services	Unlikely	Low	Ground gas assessment is ongoing but initial results indicate that there is no on-site source.	Low
Radon	Inhalation of ground gas. **PL4**	Human Health – site personnel/ensures	Unlikely	Low	The site is not in a radon affected area.	Very low

Main Exposure Pathways:
PL1 = soil ingestion, PL2 = dermal contact and ingestion, PL3 = dust inhalation; PL4 = vapour/gas inhalation; PL5 = vertical / lateral migration; PL6 = corrosion of concrete; PL7=tainting of water supply; PL8 = uptake by plants.

LEVEL OF RISK	
Very Low	
Low	
Low/Moderate	
Moderate	
Moderate/High	
High	

11. GEOTECHNICAL ASSESSMENT

11.1. SOIL CONSISTENCY

Undrained shear strength values were measured using both field hand shear vane tests and laboratory undrained triaxial tests. Results of the tests are presented in Table 36 and Table 37, respectively, which indicate the clay soils vary between stiff and very stiff. Strength test data is generally consistent with the field descriptions of the aforementioned soils.

Table 36 Summary of Hand Shear Vane Tests

LOCATION	DEPTH (m)	SHEAR STRENGTH (KPA)	CALCULATED ALLOWABLE BEARING CAPACITY (KN/M^2)
TP101	1.5	78	Firm to stiff
TP101	2.0	81	Firm to stiff
TP102	2.1	57	Firm
TP102	2.6	59	Firm
TP103	2.5	110	Stiff
TP105	1.5	51	Firm
TP105	2.0	122	Stiff
TP105	2.5	90	Firm to stiff
TP106	1.0	124	Stiff
TP106	1.5	149	Stiff
TP107	2.2	49	Firm
TP107	2.7	46	Firm
TP108	2.7	106	Stiff
TP109	0.9	117	Stiff
TP109	1.1	84	Firm to stiff
TP110	2.5	36	Soft to firm
TP110	3.0	72	Firm
TP111	1.2	144	Stiff
TP111	1.8	142	Stiff
TP112	0.5	171	Very stiff
TP112	1.0	139	Stiff
TP112	2.0	124	Stiff
TP114	3.2	65	Firm

Notes: ABC Calculated using Stroud and Butler et al 1974.
** granular content within soil tests may underestimate true shear strength.*

Results of the standard penetration tests, including undrained shear strengths derived from SPTs are included in Table 38.

Table 37 Summary of Undrained Shear Strength in Triaxial Compression – Laboratory Test

LOCATION	SAMPLE DEPTH (m)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (kN/m^2)	CONSISTENCY
WS106	0.5–1.0	Firm brown, slightly gravelly, very sandy CLAY	52	Firm

11.2. SIDE STABILITY AND EASE OF EXCAVATION

The sides of the exploratory trial pit excavations appeared to be generally stable during excavation. Locally, the Made Ground was observed to collapse during excavation at TP108 (0.8 m) and TP113 (0.8 m)

The presence of brick and concrete cobbles in addition to relict structures within the Made Ground deposits meant that in certain places, excavation was slow through the Made Ground. The natural strata were excavated with relative ease.

Table 38 Standard/Cone Penetration Test Results

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m²)	ALLOWABLE BEARING CAPACITY (kN/m²)*
WS101	1	Brown slightly gravelly CLAY.	10	10.08	N/A	Medium strength	Stiff	50.41	103.64
WS101	2	Brown slightly gravelly fine to medium SAND.	31	28.32	Medium Dense	N/A	N/A	N/A	283.20
WS101	3	Brown slightly gravelly fine to medium SAND.	16	13.91	Medium Dense	N/A	N/A	N/A	139.14
WS101	4	Brown fine to medium SAND.	30	25.35	Medium Dense	N/A	N/A	N/A	253.46
WS101	5	Brown fine to medium SAND.	11	9.13	Loose	N/A	N/A	N/A	91.26
WS102	1	MADE GROUND:	8	8.07	Loose	N/A	N/A	N/A	80.65
WS102	2	MADE GROUND:	22	20.10	Medium Dense	N/A	N/A	N/A	200.98
WS102	3	Grey slightly sandy CLAY.	20	17.39	N/A	High strength	Very Stiff	86.97	178.80
WS102	4	Brown slightly gravelly fine to medium SAND.	35	29.57	Medium Dense	N/A	N/A	N/A	295.70
WS102	5	Brown slightly gravelly fine to medium SAND.	34	28.21	Medium Dense	N/A	N/A	N/A	282.07
WS103	1	Grey slightly sandy CLAY.	9	9.07	N/A	Medium strength	Stiff	45.37	93.27

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m²)	ALLOWABLE BEARING CAPACITY (kN/m²)*
WS103	2	Brown slightly sandy slightly gravelly CLAY.	12	10.96	N/A	Medium strength	Stiff	54.81	112.69
WS103	3	Brown slightly sandy slightly gravelly CLAY.	30	26.09	N/A	High strength	Very Stiff	130.45	268.20
WS103	4	Brown fine to medium SAND.	16	13.52	Medium Dense	N/A	N/A	N/A	135.18
WS103	5	Brown fine to medium SAND.	16	13.27	Medium Dense	N/A	N/A	N/A	132.74
WS104	1	MADE GROUND:	6	6.05	Loose	N/A	N/A	N/A	60.49
WS104	2	MADE GROUND:	4	3.65	Very Loose	N/A	N/A	N/A	36.54
WS104	3	MADE GROUND:	8	6.96	Loose	N/A	N/A	N/A	69.57
WS104	4	MADE GROUND: Black fine to medium sand. (Saturated).	4	3.38	Very Loose	N/A	N/A	N/A	33.79
WS104	5	Brown fine to medium SAND.	10	8.30	Loose	N/A	N/A	N/A	82.96
WS105	1	MADE GROUND:	6	6.05	Loose	N/A	N/A	N/A	60.49
WS105	2	MADE GROUND:	5	4.57	Loose	N/A	N/A	N/A	45.68
WS105	3	Grey slightly gravelly slightly sandy CLAY.	12	10.44	N/A	Medium strength	Stiff	52.18	107.28
WS105	4	Grey slightly gravelly slightly sandy CLAY.	16	13.52	N/A	Medium strength	Stiff	67.59	138.96

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
WS105	5	Greyish brown slightly clayey fine to medium SAND.	19	15.76	Medium Dense	N/A	N/A	N/A	157.63
WS106	1	Grey slightly gravelly slightly sandy CLAY.	13	13.11	N/A	Medium strength	Stiff	65.53	134.73
WS106	2	Grey slightly gravelly slightly sandy CLAY.	35	31.97	N/A	Very high strength	Very Stiff	159.87	328.69
WS106	3	Brown fine to medium SAND.	26	22.61	Medium Dense	N/A	N/A	N/A	226.11
WS106	4	Brown fine to medium SAND.	23	19.43	Medium Dense	N/A	N/A	N/A	194.32
WS106	5	Brown clayey fine SAND.	18	14.93	Medium Dense	N/A	N/A	N/A	149.33
CP101	1	MADE GROUND:	5	5.04	Loose	N/A	N/A	N/A	50.41
CP101	2	Soft brown slightly sandy CLAY.	11	10.05	N/A	Medium strength	Stiff	50.24	103.30
CP101	3	Medium dense brown fine to medium SAND.	17	14.78	Medium Dense	N/A	N/A	N/A	147.84
CP101	4	Medium dense brown fine to medium SAND.	21	17.74	Medium Dense	N/A	N/A	N/A	177.42
CP101	5	Medium dense brown fine to medium SAND.	22	18.25	Medium Dense	N/A	N/A	N/A	182.52

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
CP101	6.5	Medium dense brown fine to medium SAND.	21	17.14	Medium Dense	N/A	N/A	N/A	171.44
CP101	8	Brown slightly gravelly CLAY.	50	40.47	N/A	Very high strength	Very Stiff	202.37	416.07
CP101	9.5	Dense brown gravelly fine to medium SAND.	50	40.30	Dense	N/A	N/A	N/A	402.97
CP102	1	MADE GROUND: Concrete.	50	50.41	Very Dense	N/A	N/A	N/A	504.07
CP102	2	MADE GROUND:	6	5.48	Loose	N/A	N/A	N/A	54.81
CP102	3	Stiff grey slightly sandy CLAY.	13	11.31	N/A	Medium strength	Stiff	56.53	116.22
CP102	4	Dense brown gravelly fine to medium SAND.	30	25.35	Medium Dense	N/A	N/A	N/A	253.46
CP102	5	Medium dense brown fine to medium SAND.	26	21.57	Medium Dense	N/A	N/A	N/A	215.70
CP102	6.5	Medium dense brown fine to medium SAND.	30	24.49	Medium Dense	N/A	N/A	N/A	244.92
CP102	8	Dense brown fine to medium SAND.	50	40.47	Dense	N/A	N/A	N/A	404.73
CP102	9.5	Dense brown fine to medium SAND.	50	40.30	Dense	N/A	N/A	N/A	402.97
CP103	1	MADE GROUND:	50	50.41	Very Dense	N/A	N/A	N/A	504.07

BOREHOLES	DEPTH (m bgl)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS 5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (kN/m^2)	ALLOWABLE BEARING CAPACITY (kN/m^2)*
CP103	2	Brown slightly sandy CLAY.	14	12.79	N/A	Medium strength	Stiff	63.95	131.48
CP103	3	Medium dense brown fine to medium SAND with interbedded gravel.	25	21.74	Medium Dense	N/A	N/A	N/A	217.41
CP103	4	Medium dense brown gravelly fine to medium SAND.	25	21.12	Medium Dense	N/A	N/A	N/A	211.21
CP103	5	Medium dense brown gravelly fine to medium SAND.	27	22.40	Medium Dense	N/A	N/A	N/A	224.00
CP103	6.5	Dense brown fine to medium SAND.	50	40.82	Dense	N/A	N/A	N/A	408.19
CP103	8	Dense brown fine to medium SAND.	50	40.47	Dense	N/A	N/A	N/A	404.73
CP103	9.5	Dense brown fine to medium SAND.	50	40.30	Dense	N/A	N/A	N/A	402.97

NOTES
* The Allowable Bearing Capacity (ABC) should be considered indicative.
The interpretation of in situ mass undrained shear strength (cu) data from SPT Blow Count (N) results and the influence of the Plasticity Index (PI) was reported in Standard Penetration Test in Insensitive Clays and Soft Rocks. Stroud (1974). The standard penetration test and the engineering properties of glacial materials subsequently. Stroud and Butler (1975) and (1989).
Allowable bearing capacity on sands. Soil Mechanics in Engineering Practice Terzaghi, K. & Peck, R.B. 1996.

11.3. PARTICLE SIZE DISTRIBUTION

Particle Size Distribution Tests have been undertaken on selected samples of granular material via wet sieve to obtain information on the soil fractions. The results are included in Table 39. The full results can be found in APPENDIX IX.

Table 39 Summary of Particle Size Distribution Test Results

LOCATION	DEPTH (m)	SOIL FRACTION (%)			
		COBBLES	GRAVEL	SAND	SILT/CLAY
CP101	2.00 (Natural)	0	15	71	14

11.4. SOIL PLASTICITY

The Atterberg limits determinations, summarised in Table 40, show the clay to be of predominantly low plasticity with discrete areas of moderate plasticity clay.

Table 40 Summary of Plasticity Index Test Results

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PASSING 425 MM SIEVE (%)	MODIFIED PLASTICITY INDEX	NHBC VOLUME CHANGE POTENTIAL
WS101	1.0	20	18	35	17	98	Low	16.6
WS103	2.0	23	23	51	28	100	Medium	28
WS106	1.0	18	20	42	22	100	Medium	22
CP102	2.0	31	23	48	25	67	Low	18.7
CP103	2.0	18	19	37	18	96	Low	17.2

The results of the Atterberg limits testing confirmed that the soils would be deemed to be “Low and Medium Change Potential” in accordance with the classification system utilised by the LABC/NHBC industry guidance.

11.5. PH AND SULPHATE

Chemical analyses for pH and soluble sulphate content contained in APPENDIX VIII (summarised in Table 41), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE *Special Digest 1* (2005).

A single location (TP103) has recorded DS3/AC2 conditions.

Table 41 Summary of pH and Sulphate Data

LOCATION	DEPTH (m)	SO_4 IN 2:1 WATER/SOIL (g/l)	PH VALUE	CLASSIFICATION
WS101	1.2	0.0616	8	DS1/AC1s
WS102	1.5	0.0728	8	DS1/AC1s
WS103	0.3	0.0607	7.6	DS1/AC1s
WS104	1.5	0.366	8.4	DS1/AC1s

LOCATION	DEPTH (m)	SO_4 IN 2:1 WATER/SOIL (g/l)	PH VALUE	CLASSIFICATION
WS105	2.8	0.0455	7.3	DS1/AC1s
TP101	0.2	0.0805	6.8	DS1/AC1s
TP102	1.5	0.255	7.2	DS1/AC1s
TP103	1.0	1.81	7.5	DS3/AC2s
TP108	2.2	0.116	7.4	DS1/AC1s
TP111	0.8	0.199	7.9	DS1/AC1s
TP112	1.2	0.0783	7.9	DS1/AC1s
TP114	1.5	0.217	7.6	DS1/AC1s

11.5.1. HIGHWAYS AND CONCRETE

MCHW Series 600 provides a criterion of 1500 mg/l for water-soluble sulfate within 500 mm of any concrete structure. A second criterion of 300 mg/l is given with respect to soils within 500 mm of steel structures.

11.6. GROUNDWATER

Perched water strikes have been located on-site during the investigation, these were typically associated with Made Ground overlying natural strata. Shallow groundwater may have resulted in reduced density of the SAND in WS101 and WS104.

11.6.1. INFLUENCING FUNCTIONAL WATERBODIES

Monitoring of groundwater is being completed as part of the ground gas assessment but not enough visits have been completed to date to determine any trends. It should be noted that seasonal variation is likely to result in potentially significant changes in groundwater levels beneath the site.

The water table can have significant effects on the foundation of a building, including:

- **Soil settlement**: Changes in the water table can cause soil to expand or contract, which can result in foundation settlement or movement. This can lead to cracks in the foundation, walls, or floors of a building.
- **Soil erosion**: High water tables can cause soil erosion, which can lead to the loss of soil support beneath the foundation. This can result in foundation settling or movement, which can be dangerous for the stability of the structure.
- **Hydrostatic pressure**: When the water table rises, the water exerts hydrostatic pressure on the foundation. This can cause foundation walls to crack or bow, which can compromise the structural integrity of the building.
- **Moisture infiltration**: High water tables can result in moisture infiltration into the foundation and surrounding soil. This can lead to mould growth, decay, and deterioration of building materials.
- **Drainage problems**: Poor drainage around a building can cause water to pool around the foundation, increasing the likelihood of soil erosion and hydrostatic pressure. This can lead to foundation settling or movement, and can also cause flooding in the basement or crawl space.

It is important to consider the effects of the water table on the foundation when designing and constructing a building. Proper drainage and foundation waterproofing can help to mitigate the effects of the water table on the foundation and improve the longevity and stability of the structure.

11.7. SITE PREPARATION

Our assessment has been based on the fact that the site will be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the *Manual of Contract Documents for Highway Works (MCHW).* This should include the following:

- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill.
- Demolition of all existing buildings and removal of all concrete hardstanding.
- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill.
- Buried structures and old foundations have been encountered on site. These should be excavated from below the proposed development footprint with the resulting void backfilled.

11.8. FOUNDATION CONDITIONS AND ASSESSMENT OF POTENTIAL BEARING CAPACITIES

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has assessed the safe allowable bearing capacity (ABC) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum. The results of this assessment are summarised in Table 42.

Table 42 Summary of ABC

GRANULAR SOILS			
Description	**Depth (Range m bgl)**	**Relative Density**	**Allowable Bearing Capacity (kN/m^2)**
Gravelly SAND	2.0–3.0	Medium Dense	139–401
Gravelly SAND	4.0–5.0	Loose–Medium Dense	82–295
Fine to medium SAND	5.0–6.5	Medium Dense	171-401
Fine to medium SAND	8.0–9.5	Dense	401
COHESIVE SOILS			
Description	**Depth (range m bgl)**	**Undrained Shear Strength (Cu) (kN/m^2)**	**Allowable Bearing Capacity (kN/m^2)**
Firm to Stiff, sandy CLAY	1.00–2.00	36-86	93–178
Firm to stiff, sandy CLAY	2.00–3.00	54–130	112–268
Gravel Clay (CP101)	8.0	202	416

Reviewing the SPT derived from the Window Sample Probeholes should be taken with care as some of the higher values may be the result of gravel resulting in high penetration values.

Across much of the site, the natural strata comprise CLAY overlying SAND. The CLAY has been shown to have an ABC ranging from 93-178 kN/m^2 at between 1.0 m and 2.0 m bgl and 112-268 kN/m^2 between 2.0 m and 3.0 m bgl. Soft CLAY was identified in TP110 with an ABC of 36 kN/m^2.

The underlying SAND can be described as medium dense increasing to very dense from depths ca. 8.0 m bgl level with ABCs ranging from 139 to 238 kN/m^2 between 2.0 and 3.0 m bgl.

At greater depths of between 4.0 m and 5.0 m bgl two locations recorded loose SAND at ca. 5.0 m bgl. This may be due to perched groundwater. However, as noted above, in the deeper cable percussion boreholes the SAND becomes increasingly dense to refusal at ca 8.0 m bgl with SPTs greater than 50 for between 245 mm and 265 mm. This would indicate an ABC of greater than 400 kN/m^2.

11.9. FOUNDATIONS OPTIONS APPRAISAL

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe allowable bearing capacity, the following recommendations have been developed for the site of the potential foundation solutions that may be adopted for future residential development. The suitable target founding stratum has been identified as the underlying firm to very stiff CLAY or underlying medium dense to dense sands.

At this time it is not possible to accurately define the foundation types due to the absence of a detailed tree survey and final development levels; however, based on our extensive experience with similar sites, we would anticipate that the final foundation solution would be a combination of the following:

- Shallow strip foundations bearing on firm to stiff gravelly CLAY from circa 1 m bgl; and
- Trench fill to support reinforced strip foundations in areas of variable ground and/or potential tree influence.
- Vibro Replacement Stone Columns (subject to re-engineering of the Made Ground)
- Piled foundation set within the dense SAND for structures in proximity to sensitive structures or infrastructure.

Given the requirements for a large-scale phase of enabling works it is highly likely that the most suitable foundation solutions for the proposed structures will be Vibro Replacement Stone Columns to support a suitably reinforced spread footing. Consideration must be given to the adjacent canal features and adjacent structures. Should an active culvert be present beneath the site piles may be required to transfer the load below the feature and prevent unacceptable structural loading.

To determine if VRSC is viable at the subject site, E3P has completed a Ground Improvement Design Risk Matrix that is summarised in Table 43.

Table 43 Ground Improvement Design Risk Matrix

RISK ITEM	COMMENT	PASS/FAIL
Soft clays with an undrained shear strength of less than 30 kN/m^2	CLAY soils have been shown to have shear strength in excess of 30 kN/m^2	PASS
Ground with peat layers close to foundation level or the base of the stone column, or where intermediate layers of peat are thicker than 200 mm, either as a single layer or the sum of the thicknesses of individual layers throughout the length of the stone column	No peat or organic layers have been recorded.	PASS
Voided filled ground, e.g. old water tanks, pottery, glass bottles, concrete rubble or brick fill of unsuitable grading	Made Ground beneath the site will require removal and processing to render the site suitable for VSC. Oversize material and relict sub-structures will require processing	PASS – on completion of enabling works

RISK ITEM	COMMENT	PASS/FAIL
	into a graded aggregate suitable for vibro treatment.	
Loose or non-engineered fill not previously subject to rising or fluctuating water levels saturation	None identified.	PASS
Filled ground still settling or expected to settle under its own weight or due to the effects of surcharging/upfilling where there is a high organic content or where decay is continuing	None identified – the site was historically filled circa 70 years ago. It is considered that the material has consolidated under self-weight settlement.	PASS
Fill, containing degradable material where organic material forms more than 15% of fill by volume	None identified.	PASS
Clays with a plasticity index greater than 40%	None identified.	PASS
Highly sensitive soils liable to collapse or remoulding	None identified.	PASS
Cohesive soils with trees in influencing distance	Plots where tree influence has been modelled and will either be subject to a piled or mass trench-fill solution.	PASS
Overall Risk Rating and Suitability for Vibratory Ground Improvement		**PASS**

It is advisable to consult with geotechnical engineers and foundation specialists who can assess the specific ground conditions and design an appropriate Vibro Stone Column system to meet the project's requirements. They will consider factors such as soil composition, depth, and spacing of the stone columns to ensure effective ground improvement and proper load distribution for the strip foundation.

Foundation depths should take account of the presence of existing and proposed trees, with foundations deepened locally to mitigate the potential for volumetric instability attributed to fluctuations in moisture content, in accordance with the requirements of NHBC standards.

It is recommended that at the working drawing stage a foundation schedule is prepared for the development, taking account of the physical change of natural clay soils and the current/proposed locations of trees.

11.10. GROUND FLOOR SLABS

Current building control regulations require that where infilled ground is present to depths in excess of 600 mm, or where the substratum is variable in terms of the structure and settlement potential, or where clay soils are present within the influence of existing or proposed trees, a suspended floor slab is required.

In this instance, it is considered that for the majority of substructures, the underlying stratum would have in excess of 600 mm of infill and, as such, a suspended floor slab will be required.

Where a cast in-situ suspended slab is utilised with no subfloor void, appropriate compressible material (heave precautions) will be required in the construction of the substructure.

In clay soils, if the foundation depth is greater than 1.5 m, allowance should be made in the design for heave. This must incorporate either a clear void of a specified minimum depth under the suspended floor, or a proprietary compressible material/void former below the underside of the floor construction.

Ground-bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5 m. Under these circumstances, a suspended floor construction should be used.

11.11. SETTLEMENT

The site has been appraised through desk-based information and site investigation data in order to inform geotechnical risk where possible. Table 44 below has been formulated to determine if settlement risks are required to be further appraised. Where any item is determined to be appraised a settlement appraisal for the site should be prepared upon receipt of development levels and layout.

Table 44 Summary of Geotechnical Information for Settlement

RISK	COMMENT	ASSESSMENT
The site is located in an area deemed to be at Risk from Ground Dissolution from desk based information	The site is in a low risk area of ground dissolution based on BGS data searches.	No further assessment
The site is in an area where geology is reported as having a compressible risk from desk based information	Peat deposits and soft alluvium have not been identified	No further assessment
Do historical maps indicate excavation features such as opencast or ponds that have been infilled?	A landfill is located to the south of the site which encroached into the south of the site. Filling commenced in circa 1945.	Likely that plots in this sector will require an engineered foundation solution.
Has the site been proven to be underlain by anthropogenic materials to an unknown specification?	Yes filled ground to a maximum proven depth of 4.5 m bgl (WS104)	Likely that plots in this sector will require an engineered foundation solution.
Have Oedometers and/or ground conditions reported compressible stratum on site?	Not undertaken as part of this phase of works.	-
Have high walls been identified on site that could result in differential settlement?	None identified.	No further assessment
Has any evidence been observed on site indicating settlement (non structural assessment)	None identified.	No further assessment
Is voided ground present beneath the site?	None identified.	No further assessment
Is the site in an area where a mobile groundwater regime is present in influencing distance of foundations and infrastructure?	None identified.	No further assessment
Will the site be subject to changes in site levels that may induce heave or settlement?	Not determined as part of this phase of works. However significant cut/fill earthworks are not considered likely.	No further assessment

11.12. HEAVE PRECAUTIONS

The site has been proven to be underlain by clay soils which are susceptible to volumetric instability due to fluctuations in moisture content, particularly within influencing distance of trees as per the NHBC/LABC conjectures zones of influence.

The clay has been determined as being of low to medium volume change potential. Table 45 shows where heave precautions are required for a trench fill, pier and beam and pile and beam foundation types which are in the zone of influence of trees which are to remain or be removed.

Table 45 Position of Heave Precautions

SITUATION	TRENCH FILL	PIER AND BEAM	PILE AND BEAM
External trench fill and pier foundations. Unless NHBC is satisfied that the soil is not desiccated compressible material should be provided to the:	Inside faces of external wall foundations deeper than 1.5 m, based on the appropriate tree height.	All faces of pier foundations deeper than 1.5 m, based on the appropriate tree height.	N/A
External ground beams. Unless NHBC is satisfied that the soil is not desiccated, compressible material or void formers should be provided to the:	N/A	Inside faces	Inside faces
Internal trench fill foundations and ground beams. Compressible material required:	No	No	No
External and internal ground beams. Compressible material, void former or void should be provided to the underside of:	N/A	All	All
Heave precautions required for proposed trees where the soil is not desiccated:	No	No	No

Note: Information taken from NHBC Standards 2024, Chapter 4.2, Table 8 – Position of heave precautions

A summary of heave precautions is presented in Table 46.

Table 46 Summary of Heave Precautions

VOLUME CHANGE POTENTIAL	VOID DIMENSION AGAINST SIDE OF FOUNDATION AND GROUND BEAM	VOID DIMENSION UNDER GROUND BEAMS, AND SUSPENDED IN-SITU CONCRETE GROUND FLOOR	VOID DIMENSION UNDER SUSPENDED PRECAST CONCRETE AND TIMBER FLOORS(1)
High	35mm	150mm	300mm
Medium	25mm	100mm	250mm
Low	0mm	50mm	200mm

In addition to the requirements of the 'Drainage' section, drainage near trees should incorporate additional provisions. Where there is a volume change potential within the ground, the provisions include:

- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.

- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

11.13. HIGHWAYS CONSTRUCTION

A programme of remediation and enabling works will be required to remediate the proposed road subgrade in accordance with the requirements of the Manual of Contract Documents for Highway Works Volume 1 Specification For Highway Works (Series 600-Earthworks) for a method compaction.

11.14. DRAINAGE

Where loose or soft materials have been identified at drainage invert levels, there will need to be a consideration for the use of reinforced pipe bedding.

Shrinkage and heave of clay soils can affect pipelines. To protect against the effects of heave, drainage should be designed:

- To take account of potential ground movement as shown in Table 47, including where pipes and services pass through substructure walls or foundations.
- With gradients which may need to be steeper.
- To use alternative means of catering for the movement when sufficient falls cannot be provided, for example, by deepening the excavation and laying pipework on a granular bedding of suitable thickness to reduce the extent of potential movement.

Table 47 Potential Ground Movement for Drainage

VOLUME CHANGE POTENTIAL	HIGH	MEDIUM	LOW
Potential ground movement	150 mm	100 mm	50 mm

11.15. EXCAVATIONS

Trial pits were generally stable in both granular Made Ground and natural strata; as such, it is considered that near-surface excavations will be feasible. In areas where Made Ground exceeded 2 m, excavations were generally less stable.

Site observations indicated that excavations should be feasible in the near-surface with normal plant; however, obstructions were identified in the near-surface, including former foundations and former floor slabs. It is anticipated that any obstructions will be grubbed out during the reduced-level dig for the substructure works.

However, due to the depth and variability of the Made Ground and the likelihood of trench collapse, it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

If local pumping of groundwater is required during the advancement of excavations for the proposed foundations then consideration should be given to the potential for dewatering gravels in the surrounding areas that may cause structural damage to building substructures in close proximity to the site.

Table 48 Civil Engineering Excavation Risk Matrix

RISK ITEM	PRESENT	COMMENT
Running Sands	No	No running sand has been identified.
Minor Water Ingress	No	Minor water ingress will require localised dewatering/sump pumping during the construction of site drainage infrastructure. Care should be taken when dewatering granular strata so as to cause instability in adjacent structures.
Shallow Bedrock	No	Shallow bedrock has not been identified.

11.16. SLOPE STABILITY

There are no significant slopes at the subject site.

11.17. CONSTRUCTION ACTIVITY AND INSPECTION

The following activities and inspections should be incorporated into the site works:

- Due to the variability of the soils at the site, it is recommended that sufficient allowance is made for the inspection of formations and subformations to foundations and pavement construction.
- Excavations, where access is required, should be subject to a risk assessment from a competent person and, where appropriate, mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 should be utilised.
- It is considered that dewatering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to the provision of space for settling tanks or an attenuation pond.
- Where access to confined spaces is required, appropriate mitigation measures should be addressed within the construction stage health and safety plan. Particular account should be taken of the gas results.
- The presence of potential contamination and mitigation measures should be addressed as part of the construction stage health and safety plan and should include measures to design out the risks, reduce their impact and, finally, to include the use of personnel protective equipment (PPE).

11.18. DEVELOPED GEOTECHNICAL RISK REGISTER

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON-SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of contaminated soils	On-site	TBC	Metals, PAH and localised ACM have been identified within the Made Ground. There is no specific remediation of the Made Ground required but a cover system will be needed in all garden and landscaped areas of the proposed development in the subject site.
Bedrock	N/A	0	Shallow bedrock has not been identified.
Cohesive Stratum overlying shallow Bedrock (<3.00m)	N/A	0	
Obstructions	All	100	Relict walls, slabs and oversized material have been identified in the sub-surface of the site.
Artificially levelled and filled platforms	On-site	10	The southern sector of the site was identified as being part of a refuse tip historically. Ground investigation has identified up to 4.5 m of Made Ground in this area.
Retaining walls	N/A	0	None have been identified.
Trench collapse	On-site	5	Most excavations remained stable during the ground investigation. Two locations observed collapse (TP108 and TP113)
Drainage Invert levels	TBC	-	To be confirmed.
Infilled canal/Culverts	On-site	5	No infilled canals are present on-site. A culvert is marked on historical maps but its presence has not been confirmed to date. Allowance should be made for it until it can be fully surveyed.
Mature trees	Southern boundary	10	Arboriculture survey is required to determine areas of potential tree influence.
Volume change potential clay	On site	100	The site is likely to be underlain by cohesive and therefore heave precautions may be required at the site.
Peat	N/A	-	None identified.
Running sands	N/A	N/A	Data searches indicate low risk and none was observed during the ground investigation.
Ground dissolution	N/A	N/A	Data searches indicate no hazard.
Concrete design	TBC	-	The majority of locations tested indicated DS1/AC1. One location identifies DS3/AC2
Low-permeability ground	On-site	70	Soakaways are unlikely to be effective in areas where low permeability cohesive deposits are present or where areas of potentially contaminated soil and groundwater are present.

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON-SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Services/sensitive structures	On-site	5	Piling may not be possible within close proximity to the culvert, if present.
Abnormal foundation solutions	TBC	TBC	Depending on site levels and layout, however, it is likely that some plots will require an engineered foundation solution.
Areas not investigated	N/A	N/A	-
Surface water features	N/A	N/A	-
Current ponds to be filled	N/A	N/A	-
Historically infilled pond	N/A	N/A	-
Quarry high wall	On-Site	5	A 'high wall' is identified, this represents a risk associated with exaggerated differential settlement to structures and infrastructure. A former refuse tip was identified in the south and with WS104 indicating up to 4.5 m of Made Ground compared with 0.8 m in TP109 there is an inference of a possible high-wall in this area.
Mining	N/A	N/A	No mining risk was identified.
Slope	N/A	N/A	-
Consolidation and Settlement	On-site	80	The presence of variable Made Ground deposits represents a risk associated with the consolidation of materials that could induce settlement to structures and infrastructure. However, it is noted that the Made Ground has been in-situ for a significant period of time and is likely to have undergone self-weight settlement.
Enabling Earthworks	On-site	100	All proposed earthworks will need to be designed by a suitably qualified geotechnical engineer in accordance with NHBC Chapter 4.6. The earthworks design will incorporate a Geotechnical Specification for Earthworks that will define protocols to ensure no unacceptable future risk.

11.19. FURTHER WORKS

Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course:

- Completion of the gas monitoring and assessment.
- Arboricultural survey.
- Plot-specific foundation schedule (upon receipt of the final development levels).
- Geotechnical Design Report (GDR)
- Geotechnical Earthworks Strategy (infrastructure).
- Remediation and enabling works strategy.
- Specification for Mitigation of Hazardous Ground Gasses and Verification Plan.

END OF REPORT

APPENDIX I
LIMITATIONS



GENERAL

1. This report and any associated works (together comprising the "Services") were compiled and carried out by E3P for the client (as present in Section 1) under the E3P “Terms of Business” or with those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under E3P Standard Terms and Business as included within our proposal to the Client.

3. Project-specific appointment documents may be agreed upon at our discretion and a charge may be levied for both the time to review and finalise appointment documents and also for associated changes to the appointment terms. E3P reserves the right to amend the fee should any changes to the appointment terms create an increased risk to E3P.

4. The report needs to be considered in light of the proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEOENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

5. Coverage: This section covers reports with the following titles or combination of titles: Phase 1; Desktop Study; Geoenvironmental Assessment; Development Appraisal; Preliminary Environmental Risk Assessment; Constraints Report; Due Diligence Report; Geotechnical Development Review; Environmental Statement; Environmental Chapter; Baseline Environmental Assessment; Project Scope Summary Report (PSSR), Program Environmental Impact Report (PEIR), Geotechnical Development Risk Register; Agricultural Land Assessment; Mineral Safeguarding Assessment; Desk Top Coal Mining Risk Assessment; Hydrogeological Appraisal; Construction Environmental Management Plan; and Site Water Management Plan.

6. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walkover inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. E3P cannot be held responsible for any disclosures that are provided post-production of our report and will not automatically update our report.

7. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, E3P reserves the right to review such information and, if warranted, to modify the opinions accordingly.

8. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

9. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and does not constitute or replace full and proper surveys completed by suitably qualified and experienced specialists in these fields.

10. E3P does not warrant work/data undertaken/provided by others.

INTRUSIVE INVESTIGATION REPORTS

11. Coverage: The following report titles (or combination) may cover this category of work: Geoenvironmental Site Investigation; Geotechnical Assessment; GIR (Ground Investigation Reports); Preliminary Environmental And Geotechnical Risk Assessment; Preliminary Summary; Coal Mining Risk Assessment, Ground Gas Addendum; and, Geotechnical Risk Register.

12. The investigation has been undertaken to provide information concerning either:

    I. The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or

    II. Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

13. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

14. Unless otherwise specified in the scope of works, any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

15. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

16. For geotechnical investigations, the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

17. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

18. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

19. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, E3P has used reasonable skill and care to extrapolate conditions between these points based on assumptions to develop our interpretation and conclusions.

20. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation and at the time of the investigation.

21. Conditions can change between investigation points both spatially and over time and these interpretations should therefore be considered indicative. The assessment of extreme weather events and their impact on ground conditions is not within the scope of E3P's work.

22. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated with the risk assessment process have been outlined within the body or associated appendix of the report.

23. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

24. Where soil contamination concentrations recorded as part of this investigation are used for commentary on the potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed and the waste classification and any subsequent disposal option agreed upon with licenced subcontractors and/or the relevant regulators.

25. The results of the asbestos testing are factually reported and interpretation is given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and/or trace loose asbestos fibres within the soil matrix at the site.

26. If costs have been included in relation to additional site works, and/or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

27. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

28. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIATION AND ENABLING WORK STRATEGY REPORTS

29. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected based on the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

30. The outputs of the Detailed Quantitative Risk Assessments are based upon the manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

31. Before adoption on-site, assessment criteria will need to be discussed and agreed upon with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatoy Authority engagement are not within the control of E3P. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

32. E3P does not accept liability for any subcontract work that has not been completed in strict accordance with an approved E3P Remediation and Enabling Works Strategy.

GEOTECHNICAL DESIGN REPORT (GDR)

33. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS AND BUILD PHASE MITIGATION)

34. These reports are factual and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of earthworks or remedial works.

35. The data is presented and will be compared with assessment criteria.

APPENDIX II
GLOSSARY



TERMS

ACM	Asbestos-containing material	**MMP**	Materials management plan
ADS	Acoustic design statement	**ND**	Not detected
AST	Above-ground storage tank	**NDP**	Nuclear density probe
BGS	British Geological Survey	**NMP**	Noise management plan
BSI	British Standards Institute	**NPSE**	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	**NR**	Not recorded
CA	Coal Authority	**PAH**	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	**PCB**	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	**PI**	Plasticity index
CIRIA	Construction Industry Research Association	**PID**	Photo ionisation detector
CLEA	Contaminated land exposure assessment	**POS**	Public open space
CML	Council of Mortgage Lenders	**PPE**	Personnel protective equipment
CoC	Contaminants of concern	**ProPG**	Professional practice guidance
CSM	Conceptual site model	**QA**	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	**SGV**	Soil guideline value
DWS	Drinking water standard	**SPH**	Separate-phase hydrocarbon
EA	Environment Agency	**SPT**	Standard penetration test
EQS	Environmental quality standard	**SVOC**	Semi-volatile organic compound
FFL	Finished floor level	**TPH**	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	**TPH CWG**	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	**UKWIR**	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	**UST**	Underground storage tank
HCV	Health criteria value	**VCC**	Vibro-concrete column
ICSM	Initial conceptual site model	**VOC**	Volatile organic compound
LEL	Lower explosive limit	**VRSC**	Vibro-replacement stone columns
LMRL	Lower method reporting limit	**VSC**	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	**WHO**	World Health Organisation

MCV	Moisture condition value	**WRAP**	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	**WTE**	Water table elevation
m	Metres	**ppm**	Parts per million
km	Kilometres	**mg/m^3**	Milligram per metre cubed
% v/v	Percent volume in air	**m bgl bgl**	Metres below ground level
mb	Millibars (atmospheric pressure)	**m bcl**	Metre below cover level
l/hr	Litres per hour	**mAOD**	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	**kN/m^2**	Kilonewtons per metre squared
ppb	Parts per billion	**µm**	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	**SSRT**	Site Specific Remediation Target
PSD	Particle Size Distribution	**DD**	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	**Mc**	Moisture Content
ρ	Bulk Density	**GPR**	Ground Penetrating Radar
NDP	Nuclear Density Probe	**FFL**	Finished Floor Level
LEL	Lower Explosive Limit	**UKWIR**	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	**LOD**	Limit of Detection
PFAS	Per- and Poly-Fluorinated Substances	**PFOA**	Perfluorooctanoic Acid

APPENDIX III
RISK CLASSIFICATION



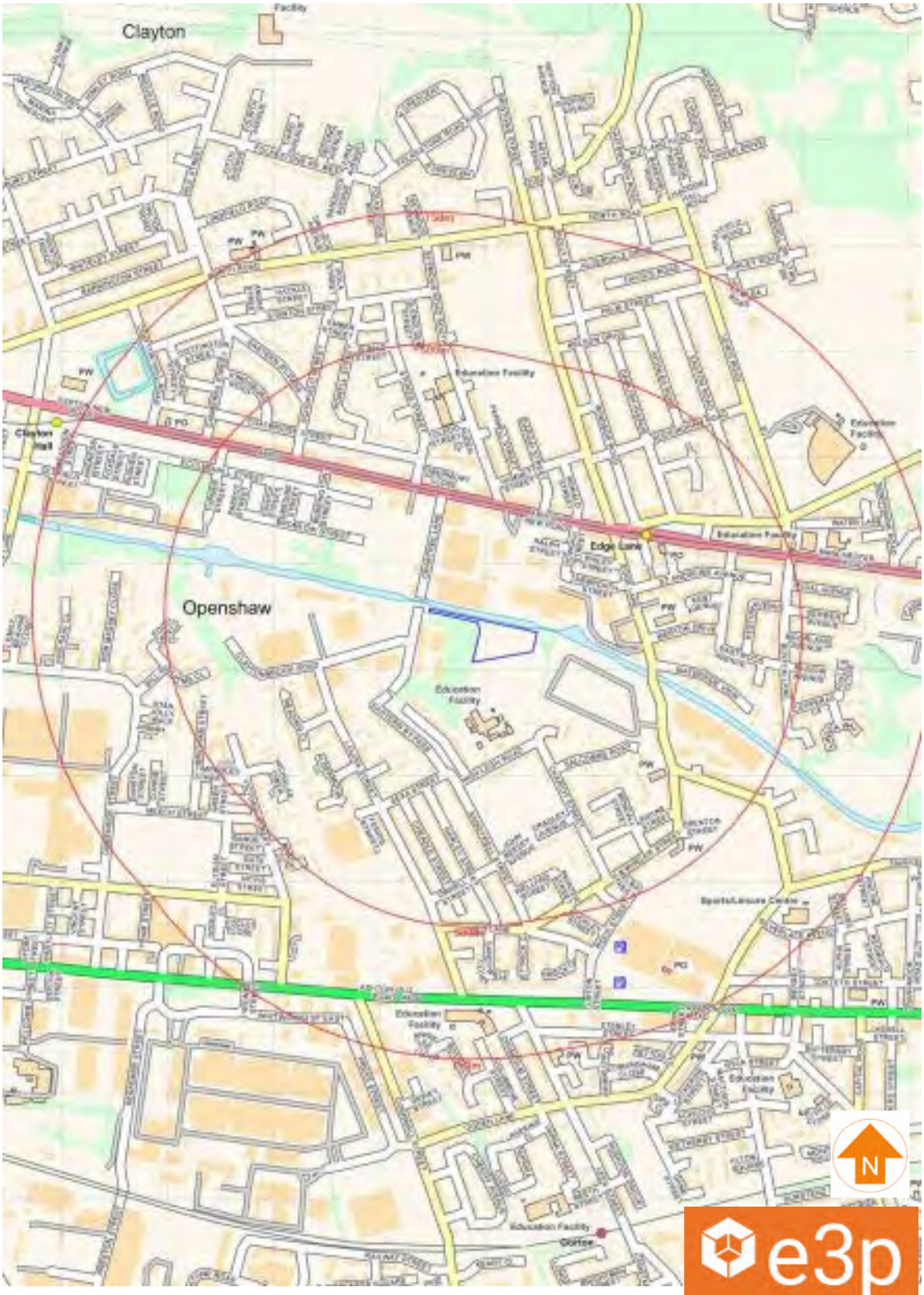
RISK CLASSIFICATION

RISK	DEFINITION
Low	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property.
Low Moderate	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property with regard to the proposed use. However, minor issues may require further consideration in the event of future redevelopment of the Site.
Moderate	Some potential contaminated land liabilities/geotechnical constraints are likely to affect the property as a result of historical and/or current activities. The risks identified are unlikely to pose an immediate significant issue but the purchaser/developer may wish to make further enquiries of the vendor or undertake further environmental improvements. Redevelopment of the Site will likely require further site investigation.
Moderate High	Some potentially significant contaminated land liabilities/geotechnical constraints have been identified at the property that requires further assessment, including intrusive ground investigations.
High	Significant potential contaminated land liabilities/geotechnical constraints have been identified at the property. Further assessment including intrusive ground investigation will be required to determine the level of risk and associated liability.

APPENDIX IV
DRAWINGS



DRAWING 17-548-001 – Site Location Plan





Site Features

- Hard Standing
- Car Park
- Site Cabins
- Stockpiles
- Skips
- Raised Area

Notes:

P1	REVA	17.04.2024	EB	AE	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 17.04.2024

Drawing No: 002

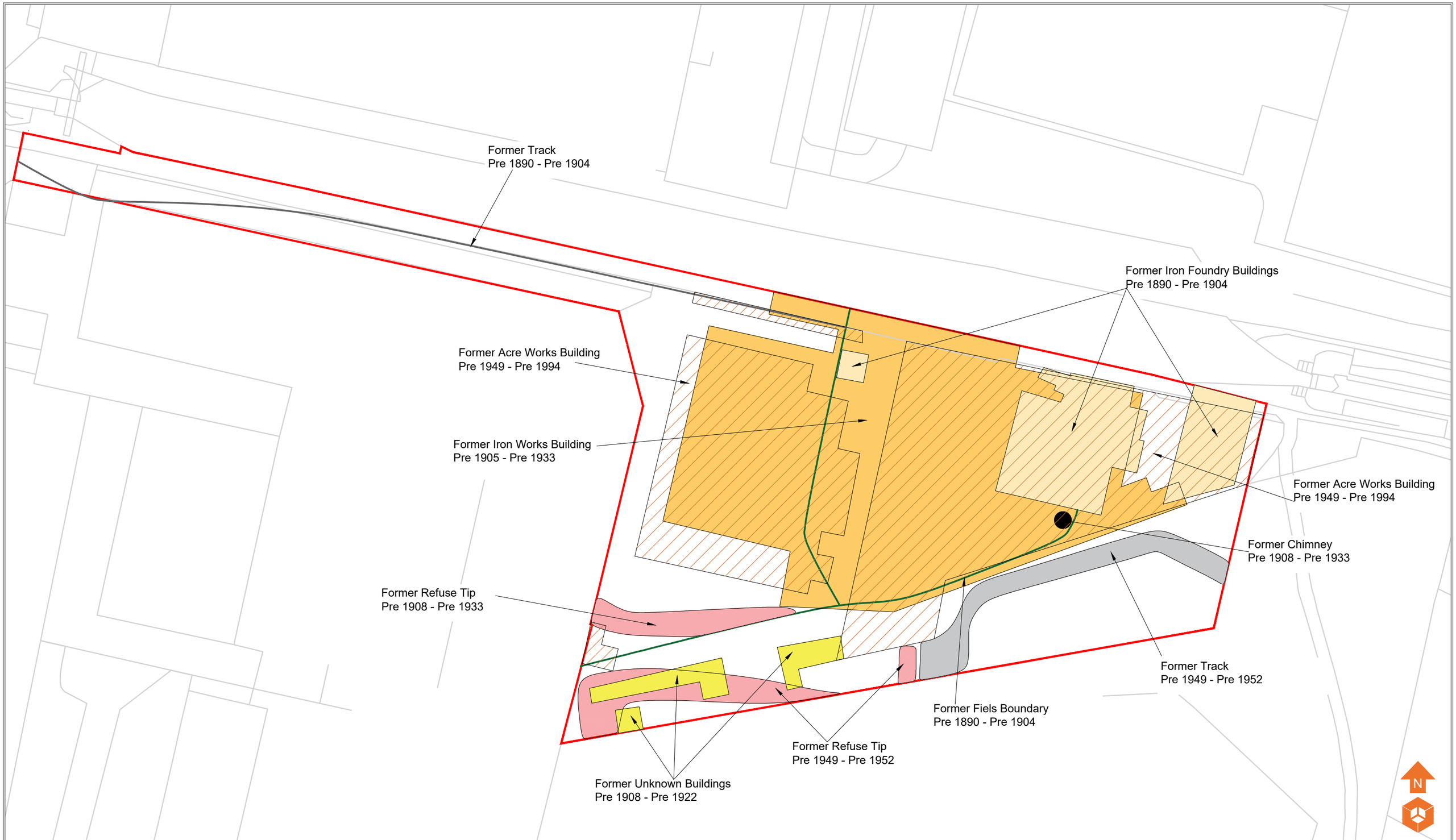
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Job Title: Crabtree Lane, Manchester

Drawing Title: Site Features Plan

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Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
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Website: www.e3p.co.uk

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Historical Features

- Former Track
- Former Refuse Tip
- Former Unknown Buildings
- Former Acre Works Building
- Former Iron Works Building
- Former Iron Foundry Buildings
- Former Chimney
- Former Track / Footpath
- Former Field Boundaries

Notes:

P1	REVA	18.04.2024	EB	AE	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 18.04.2024

Drawing No: 003

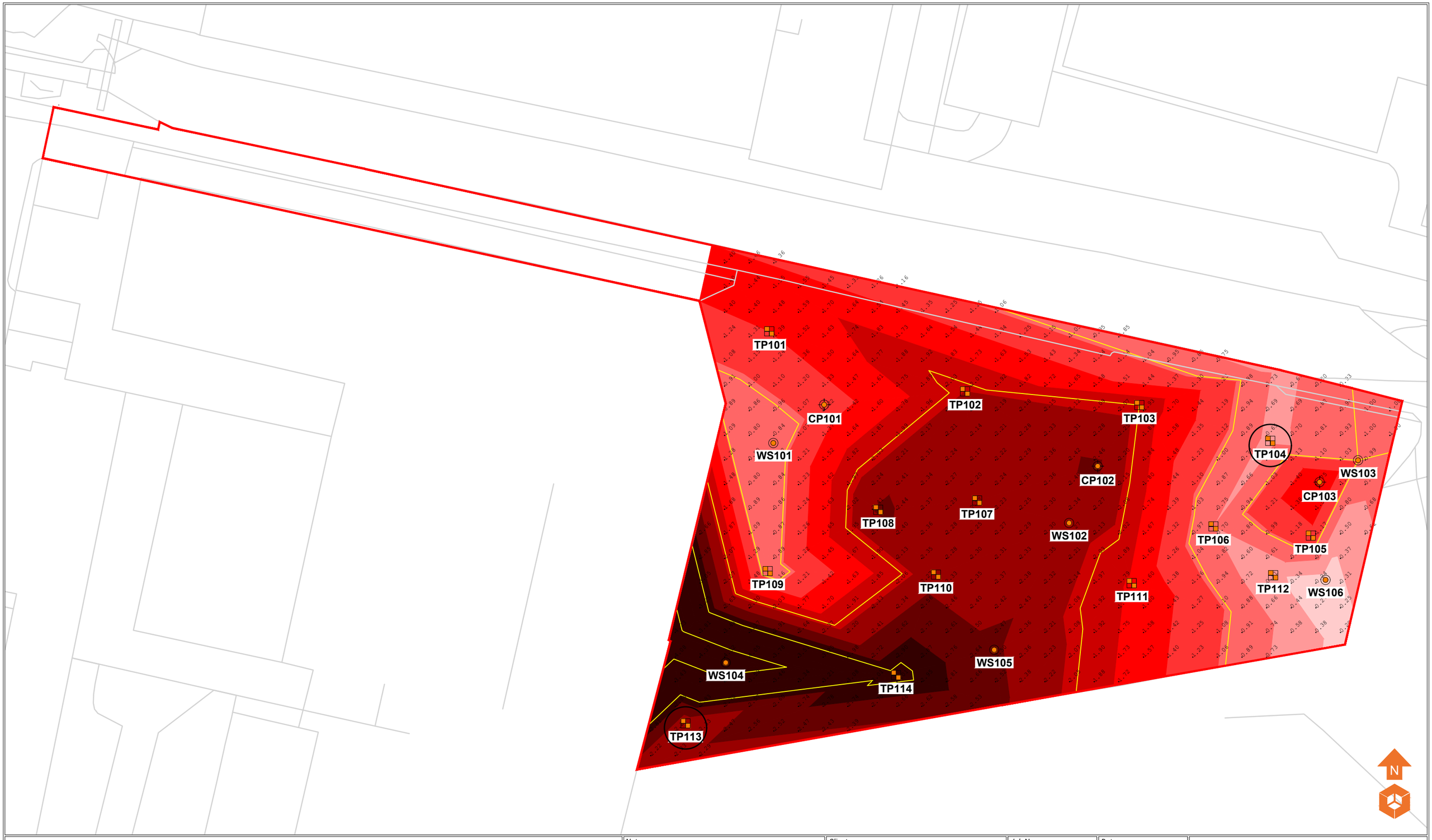
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Job Title: Crabtree Lane, Manchester

Drawing Title: Historical Features Plan

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Location Symbols

- Approximate Window Sample Probehole Location (E3P Location March 2024)
- Approximate Trial Pit Location (E3P Location March 2024)
- Approximate Cable Percussive Borehole Location (E3P Location March 2024)
- Base of Made Ground Not Encountered

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.34m
- Depth of Made Ground 0.35 - 0.69m
- Depth of Made Ground 0.70 - 1.04m
- Depth of Made Ground 1.05 - 1.39m
- Depth of Made Ground 1.40 - 1.74m
- Depth of Made Ground 1.75 - 2.09m
- Depth of Made Ground 2.10 - 2.44m
- Depth of Made Ground 2.45 - 2.79m
- Depth of Made Ground >2.80m

Notes:

P1	REVA	18.04.2024	EB	AE	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 18.04.2024

Drawing No: 006

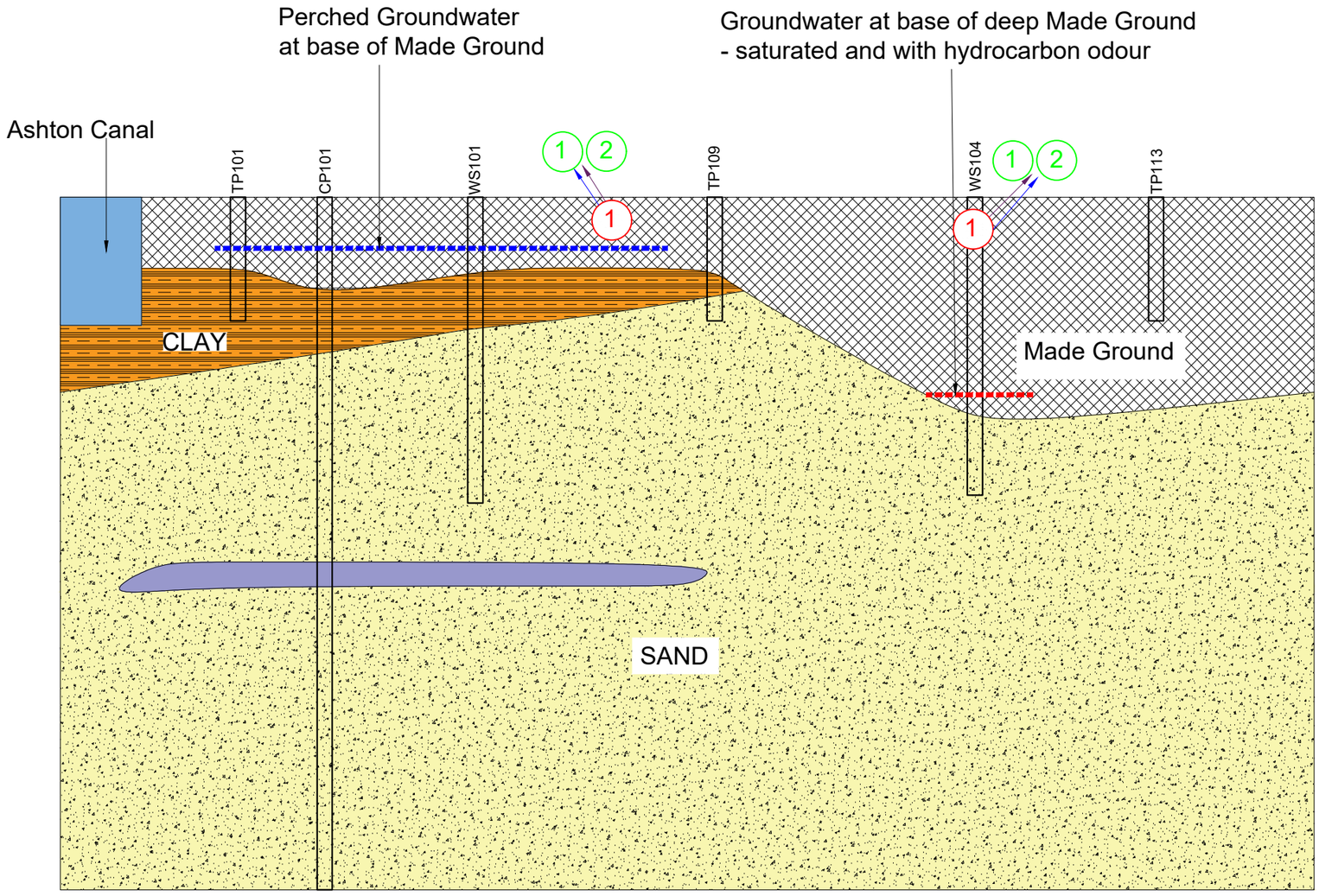
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Job Title: Crabtree Lane, Manchester

Drawing Title: Depth of Made Ground Plan

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Geology Key
- Made Ground
- Clay
- Sand
- Groundwater

Sources
1. Arsenic, Lead, PAH
2. ACM

Pathways
- Dermal Contact / Ingestion
- Inhalation

Receptors
1. Future End Users
2. Construction Worker

Notes:

P1	REVA	18.04.2024	EB	AE	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 18.04.2024

Drawing No: 010

Scale: NTS

Job Title: Crabtree Lane, Manchester

Drawing Title: Conceptual Site Model

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Location Symbols

- Approximate Window Sample Probehole Location (E3P Location March 2024)
- Approximate Trial Pit Location (E3P Location March 2024)
- Approximate Cable Percussive Borehole Location (E3P Location March 2024)

Notes:

P1	REVA	18.03.2024	CB	LC	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 18.03.2024

Drawing No: 005

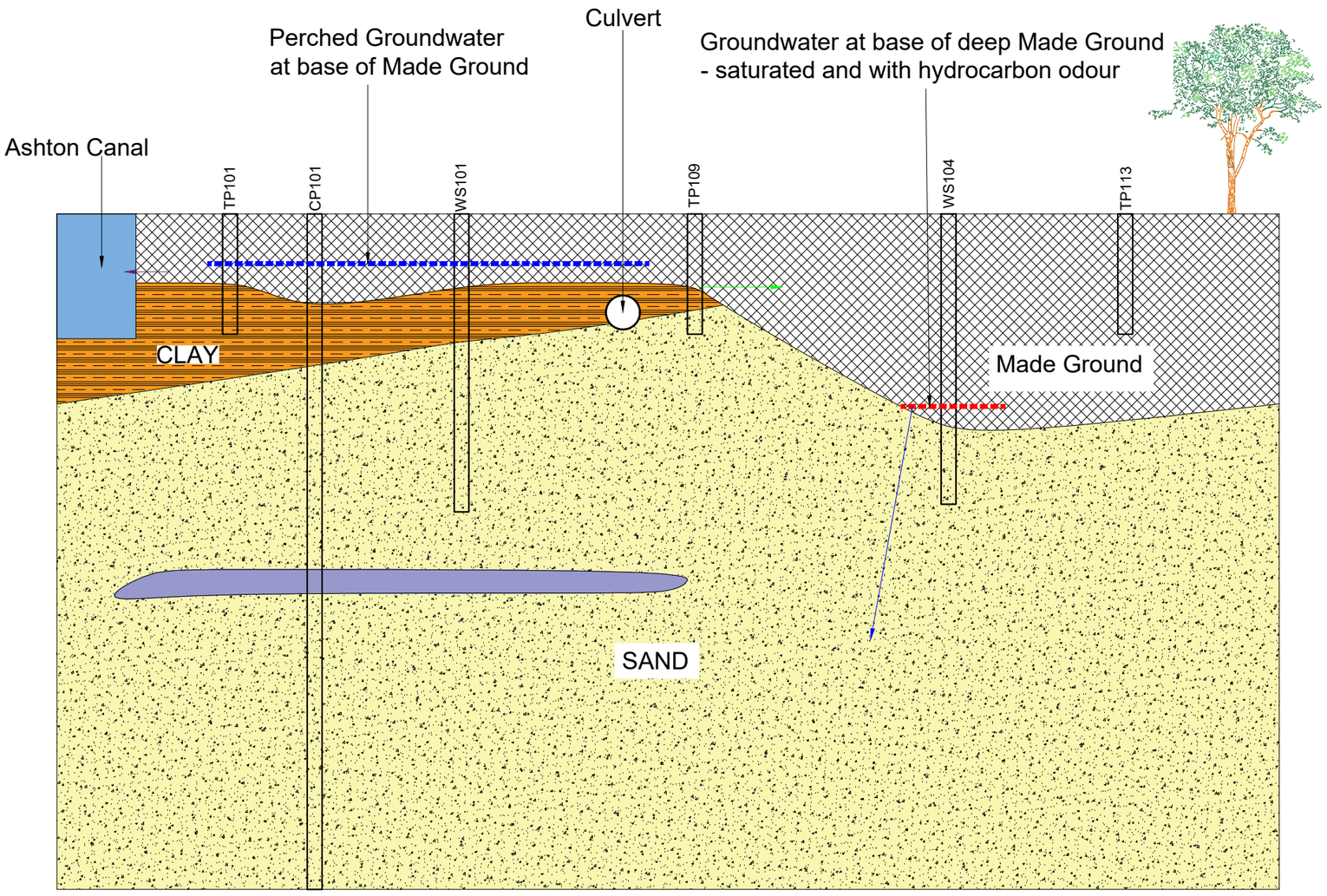
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Job Title: Crabtree Lane, Manchester

Drawing Title: Exploratory Hole Location Plan

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Geology Key

- Made Ground
- Clay
- Sand
- Groundwater

Pathways

- Vertical Migration in Granular Drift
- Lateral Migration to Ashton Canal
- Lateral Migration to Culvert

Notes:

Phase	Issue	Date	Drawn	Checked	PM
P1	REVB	22.04.2024	EB	AE	AE
P1	REVA	18.04.2024	EB	AE	AE

Client: Connell Brothers

Job No: 17-548

Date: 22.04.2024

Drawing No: 011

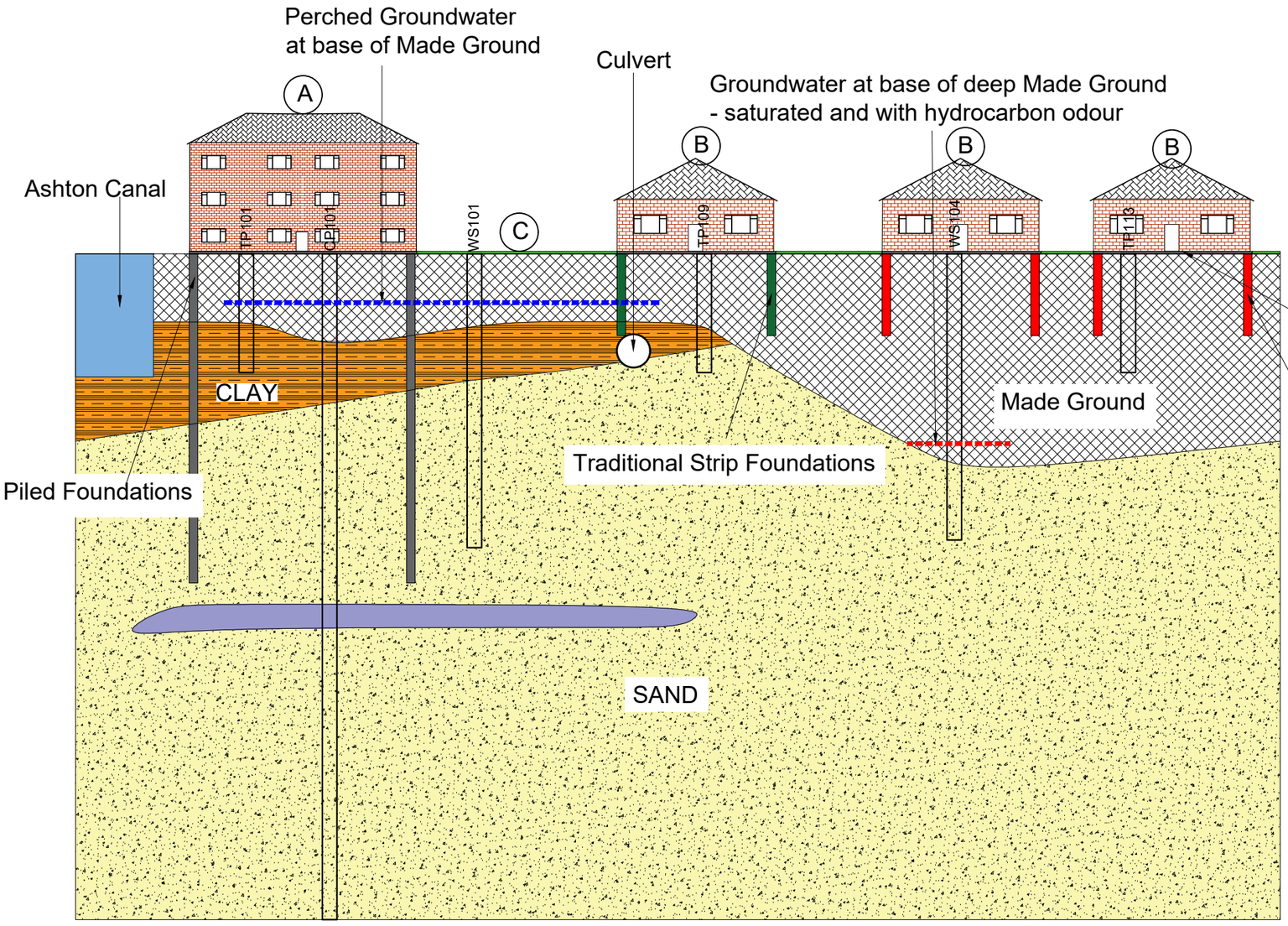
Scale: NTS

Job Title: Crabtree Lane, Manchester

Drawing Title: Groundwater Conceptual Site Model

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Geology Key

- Made Ground
- Clay
- Sand
- Groundwater

Site Features

- (A) Apartments
- (B) Low Rise Dwellings
- (C) Cover Systems to Gardens

Notes:

Phase	Issue	Date	Drawn	Checked	PM
P1	REVB	22.04.2024	EB	AE	AE
P1	REVA	18.04.2024	EB	AE	AE

Client: Connell Brothers

Job No: 17-548

Date: 22.04.2024

Drawing No: 012

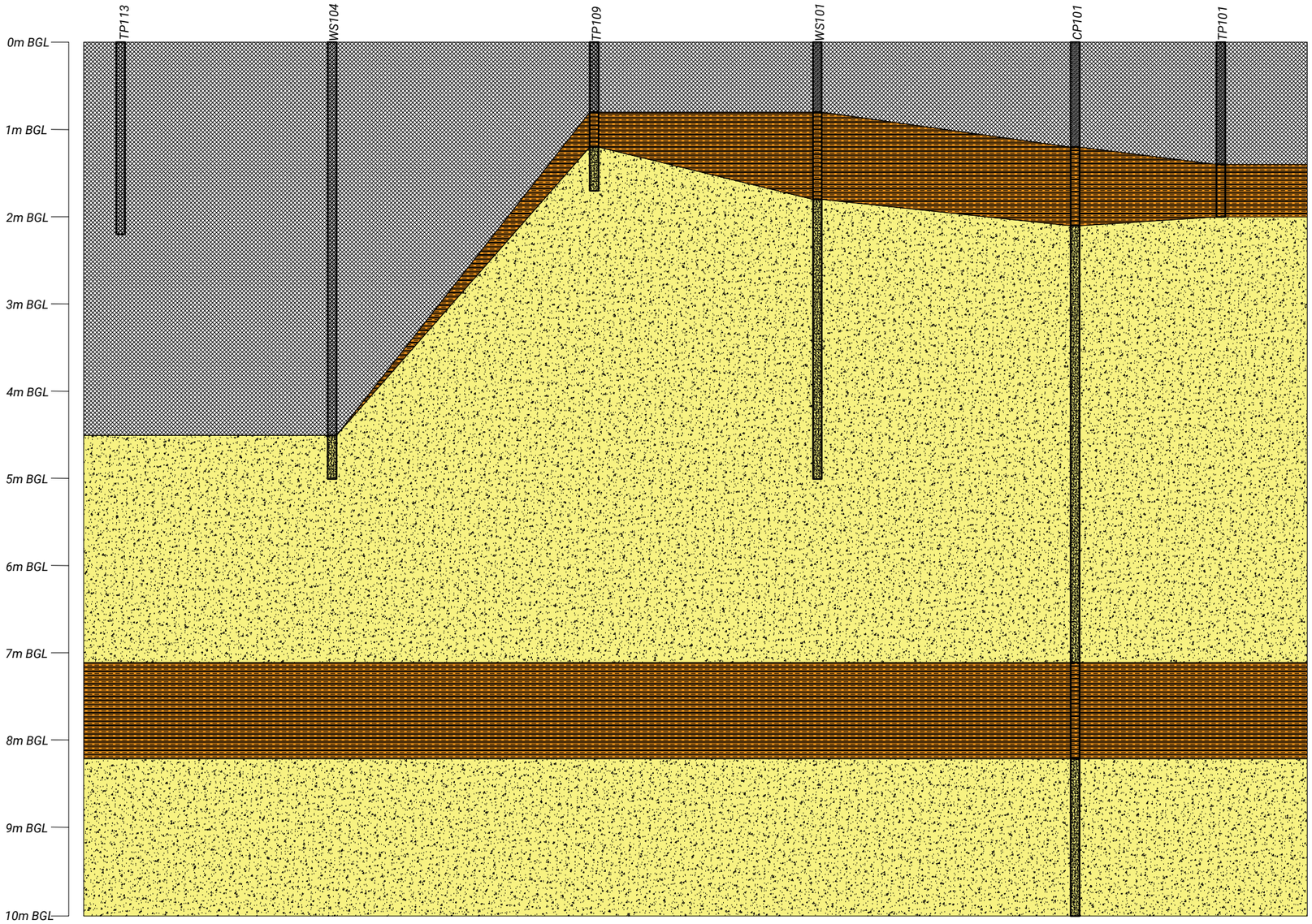
Scale: NTS

Job Title: Crabtree Lane, Manchester

Drawing Title: Developed Conceptual Site Model

Environmental Engineering Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
E-mail: info@e3p.co.uk
Website: www.e3p.co.uk

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Geology Key

- Made Ground
- Clay
- Sand

Notes:

P1	REVB	22.04.2024	EB	AE	AE
P1	REVA	19.04.2024	EB	AE	AE
Phase	Issue	Date	Drawn	Checked	PM

Client: Connell Brothers

Job No: 17-548

Date: 22.04.2024

Drawing No: 013

Scale: NTS

Job Title: Crabtree Lane, Manchester

Drawing Title: Geological Cross Section

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APPENDIX V
PHOTOGRAPHS



PLATE 1



PLATE 2



PLATE 3

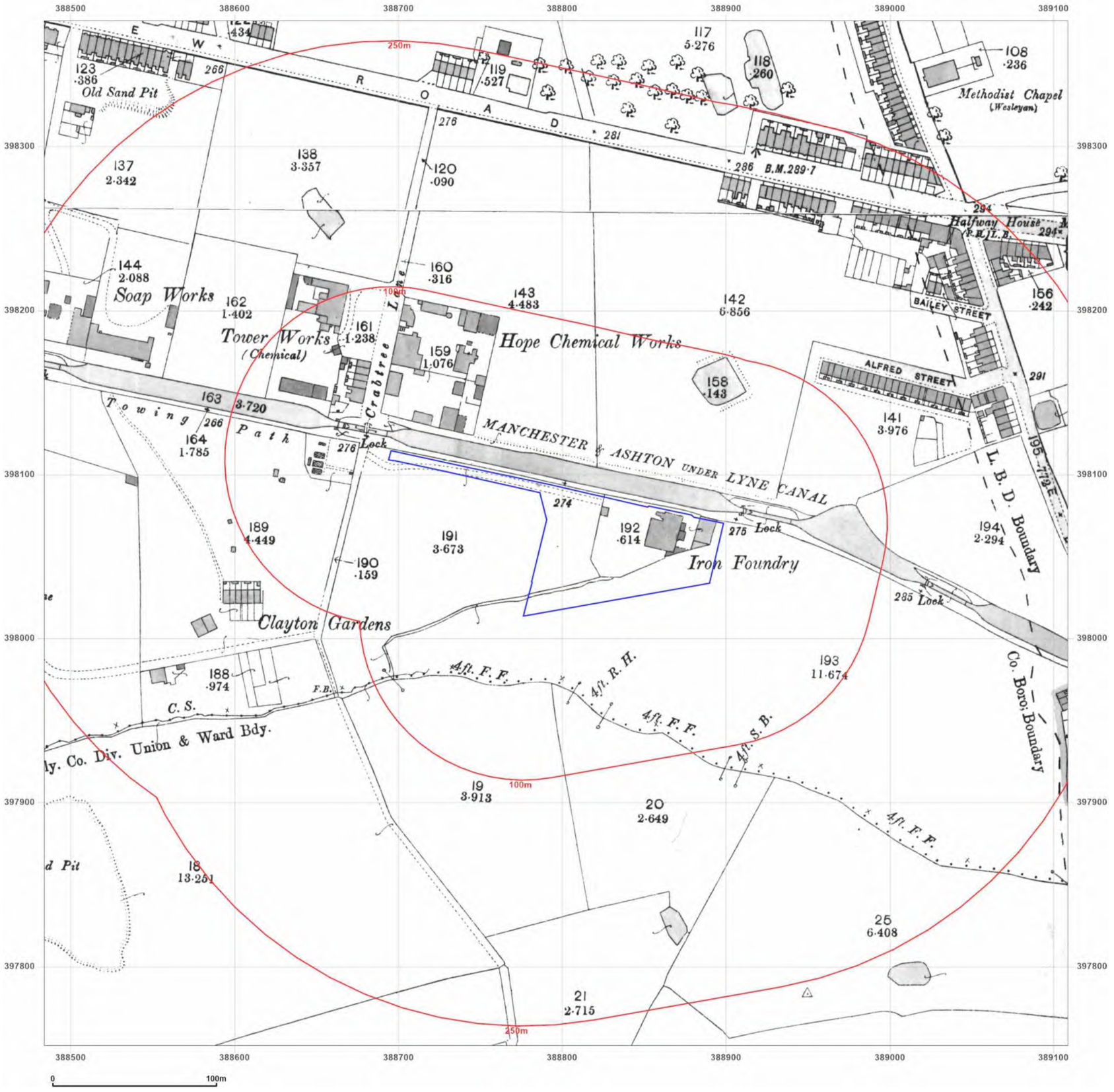


PLATE 4



APPENDIX VI
HISTORICAL MAPS





Groundsure INSIGHTS

Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: County Series

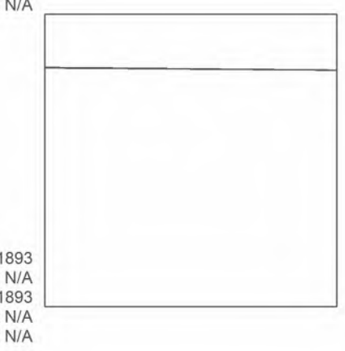
Map date: **1893**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1893
Revised N/A
Edition 1893
Copyright N/A
Levelled N/A



Surveyed 1893
Revised N/A
Edition 1893
Copyright N/A
Levelled N/A

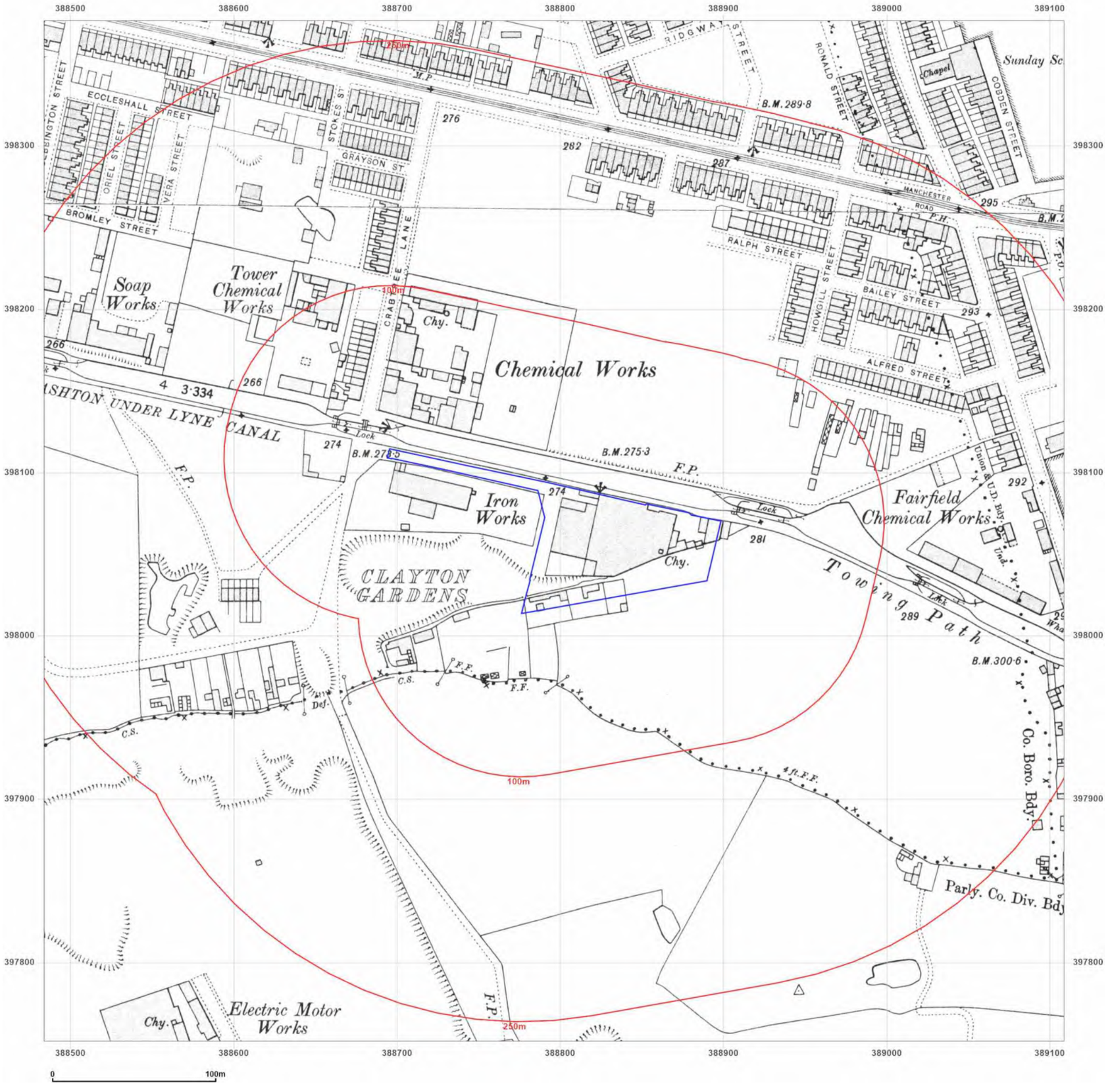
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Groundsure INSIGHTS

Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: County Series

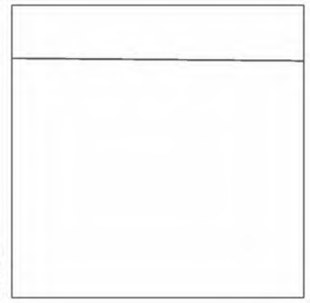
Map date: **1908**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1891
Revised 1905
Edition 1908
Copyright N/A
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Revised 1905
Edition 1908
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Groundsure INSIGHTS

Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: County Series

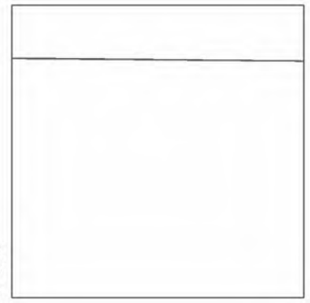
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Scale: 1:2,500

Printed at: 1:2,500

N
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Edition 1922
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Levelled 1915



Surveyed 1922
Revised 1916
Edition 1922
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Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: County Series

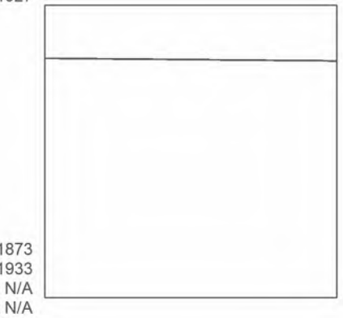
Map date: **1932-1933**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1873
Revised 1932
Edition N/A
Copyright N/A
Levelled 1927



Surveyed 1873
Revised 1933
Edition N/A
Copyright N/A
Levelled 1927

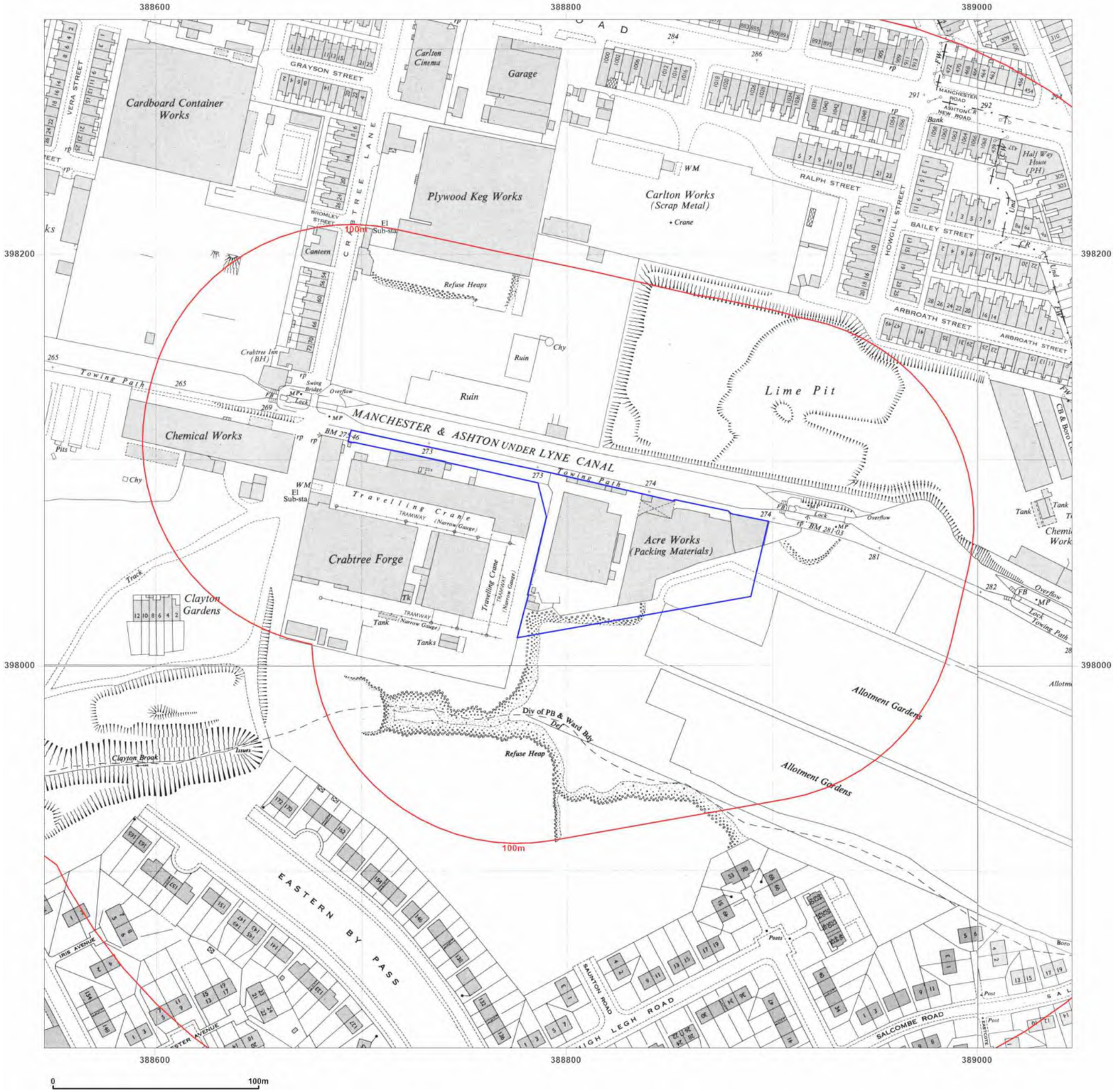
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Site Details:

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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

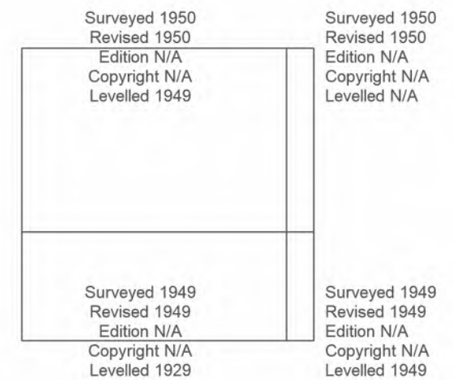
Map Name: National Grid

Map date: **1949-1950**

Scale: 1:1,250

Printed at: 1:2,000

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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1949-1951**

Scale: 1:2,500

Printed at: 1:2,500

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Revised 1950
Edition N/A
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1950-1952**

Scale: 1:1,250

Printed at: 1:2,000

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Edition N/A
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Revised N/A
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Levelled N/A

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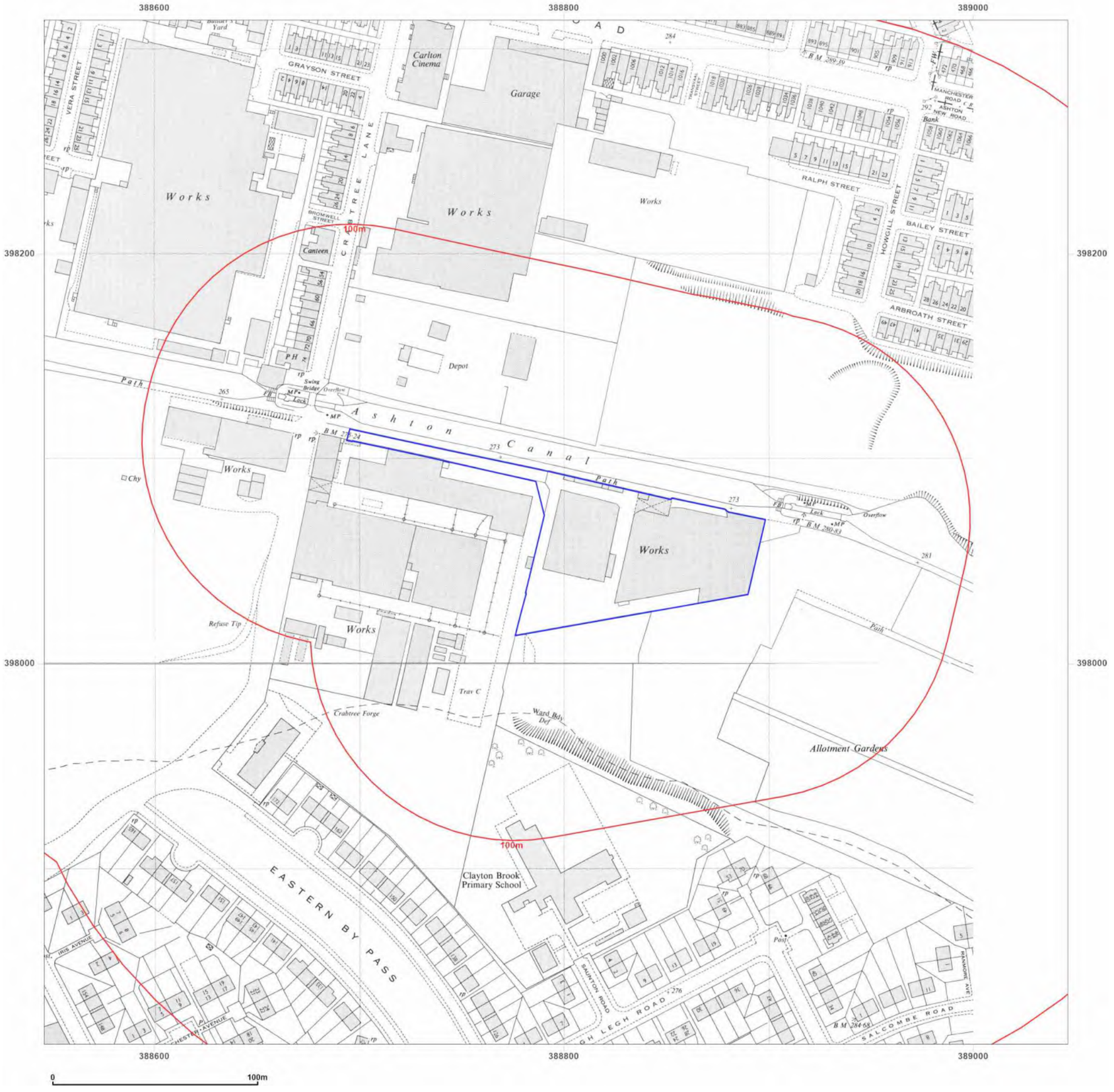
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1964-1968**

Scale: 1:1,250

Printed at: 1:2,000

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Copyright 1964
Levelled 1959

Surveyed 1949
Revised 1967
Edition N/A
Copyright 1968
Levelled 1964

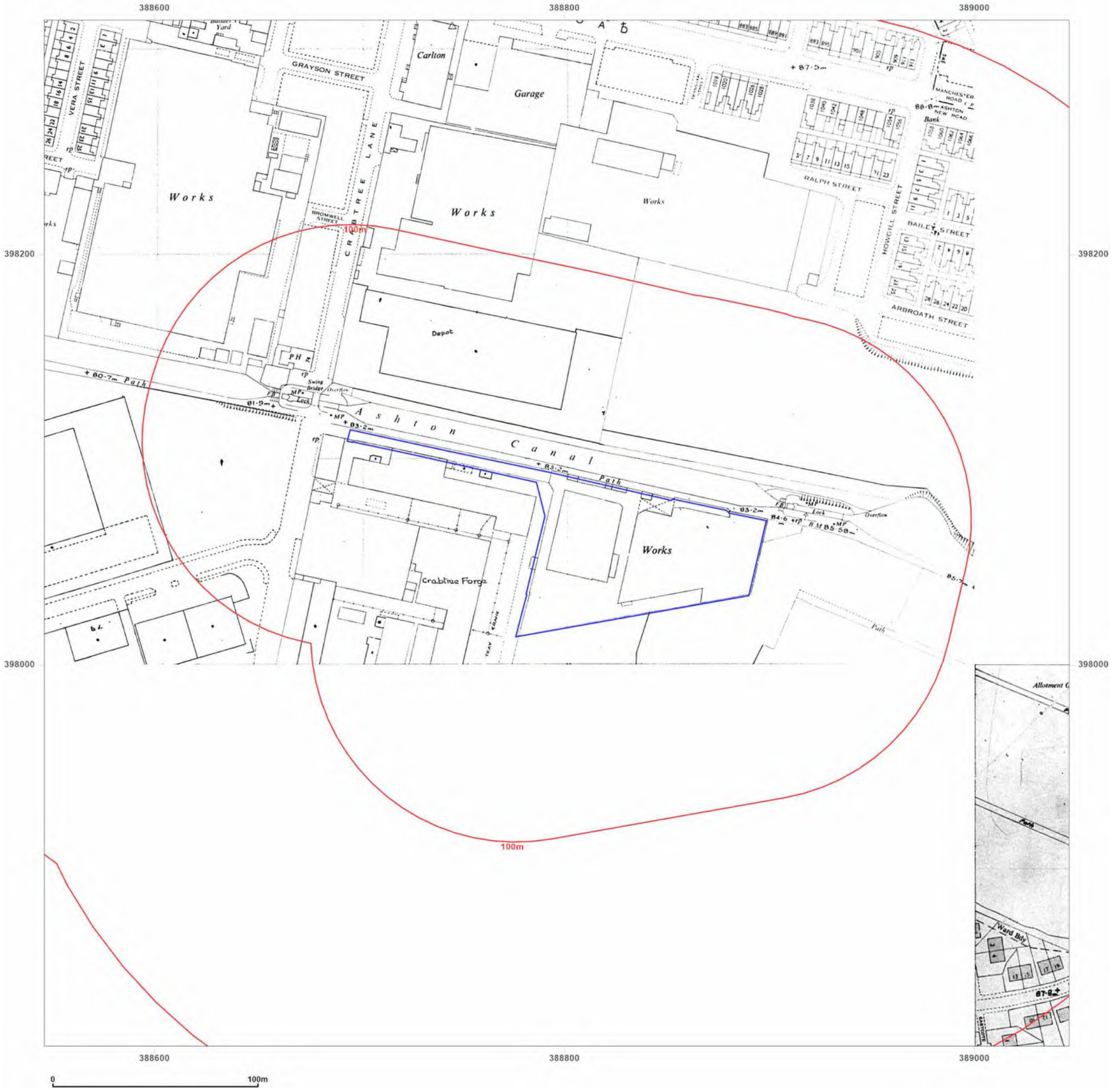
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Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

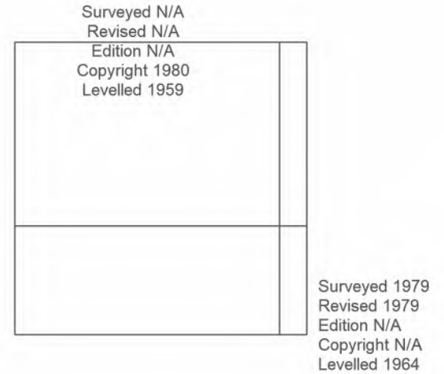
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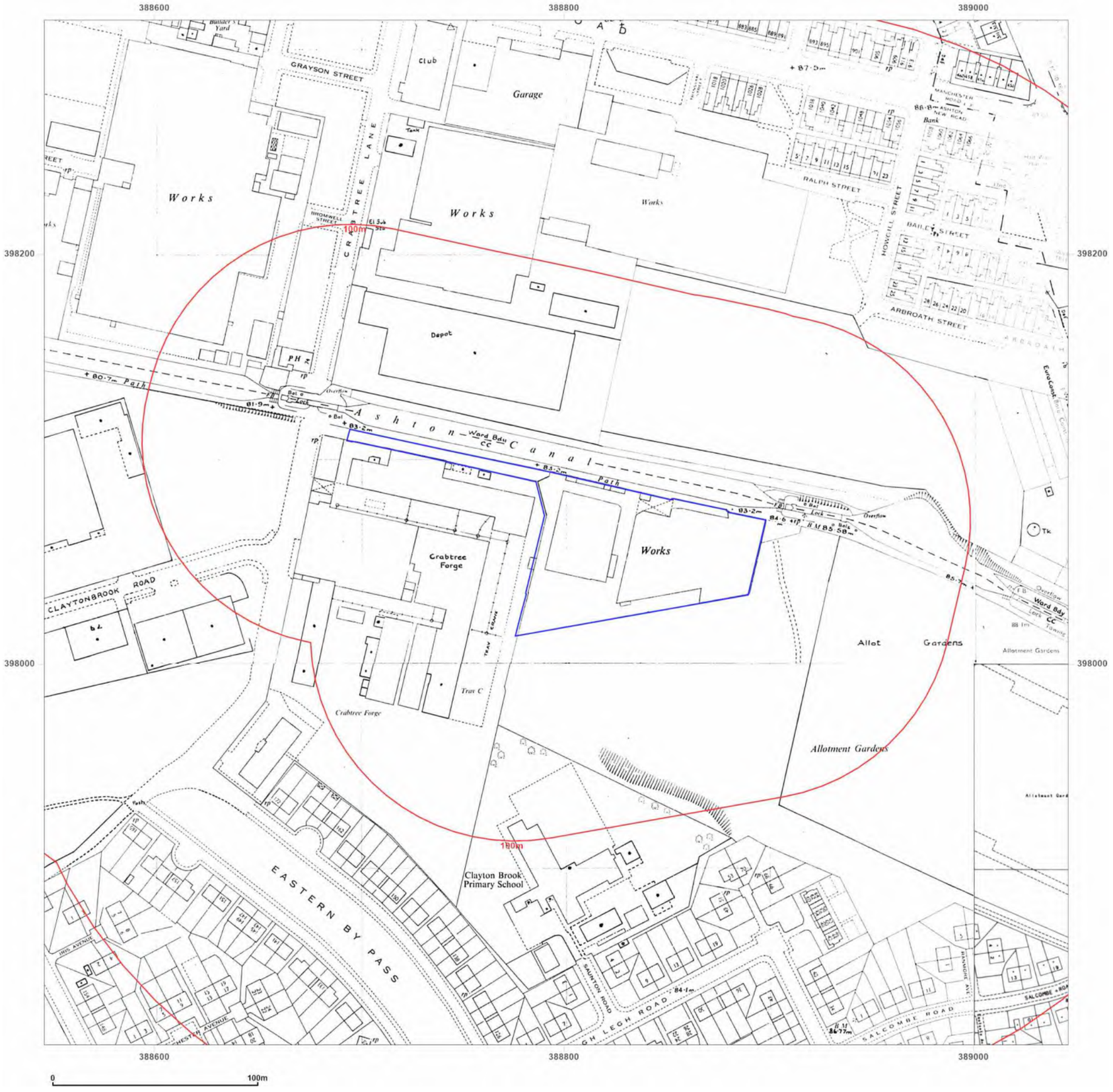
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1985-1987**

Scale: 1:1,250

Printed at: 1:2,000

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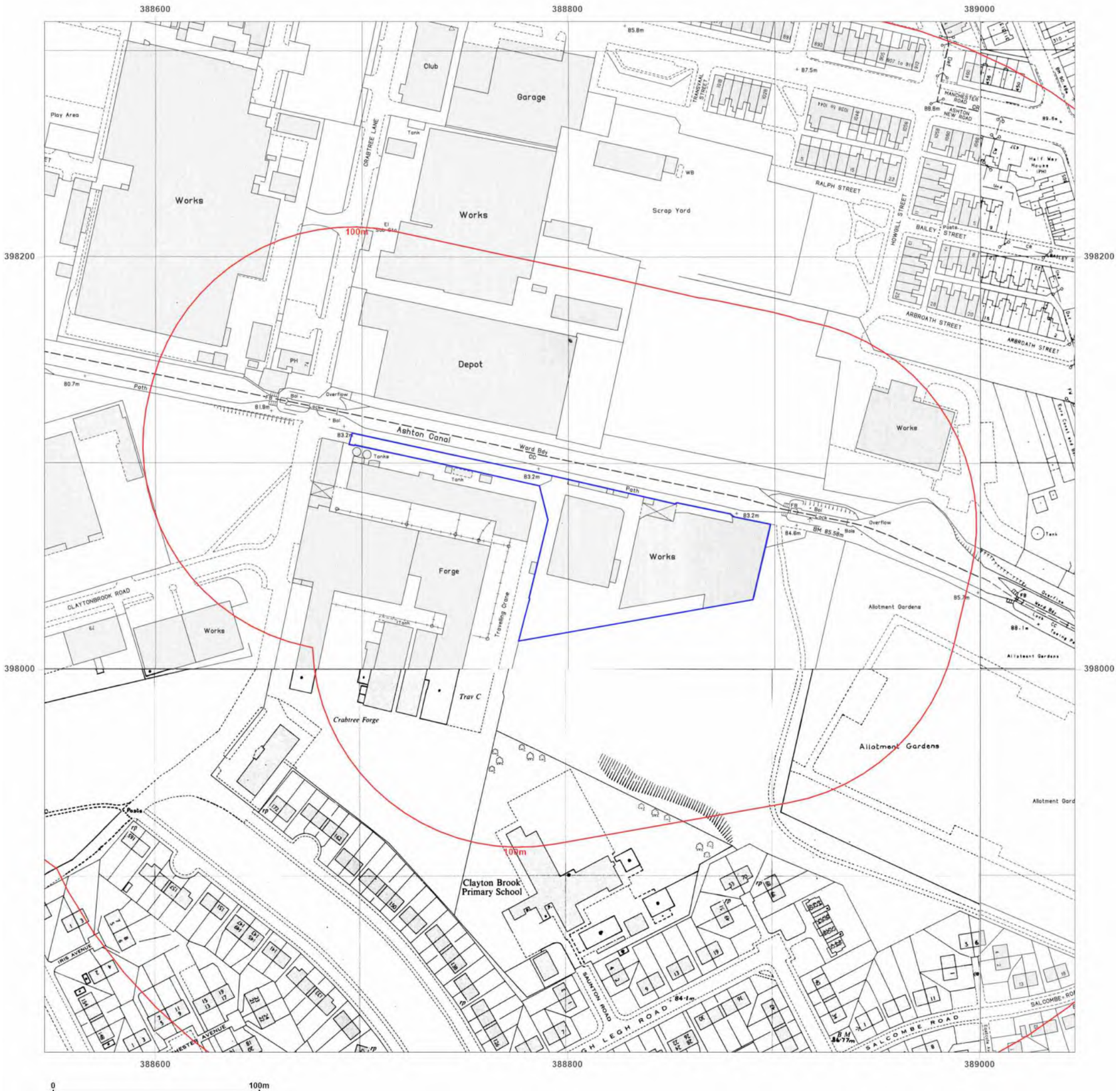
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1988-1991**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1950 Revised 1988 Edition N/A Copyright 1988 Levelled 1964	Surveyed 1950 Revised 1971 Edition N/A Copyright 1991 Levelled N/A
Surveyed 1964 Revised 1991 Edition N/A Copyright 1991 Levelled 1964	Surveyed 1957 Revised 1987 Edition N/A Copyright 1988 Levelled 1964

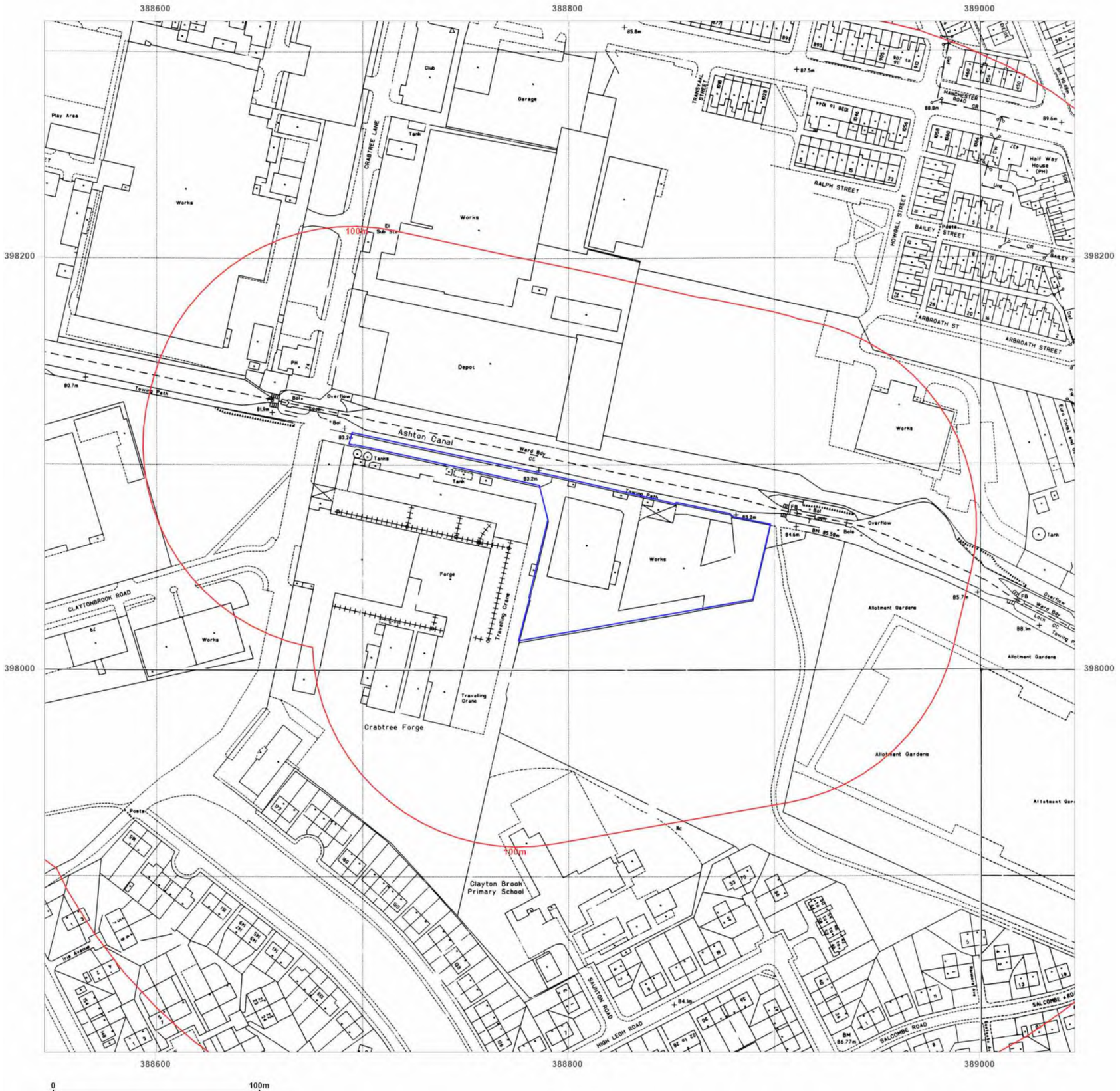
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1990-1992**

Scale: 1:1,250

Printed at: 1:2,000

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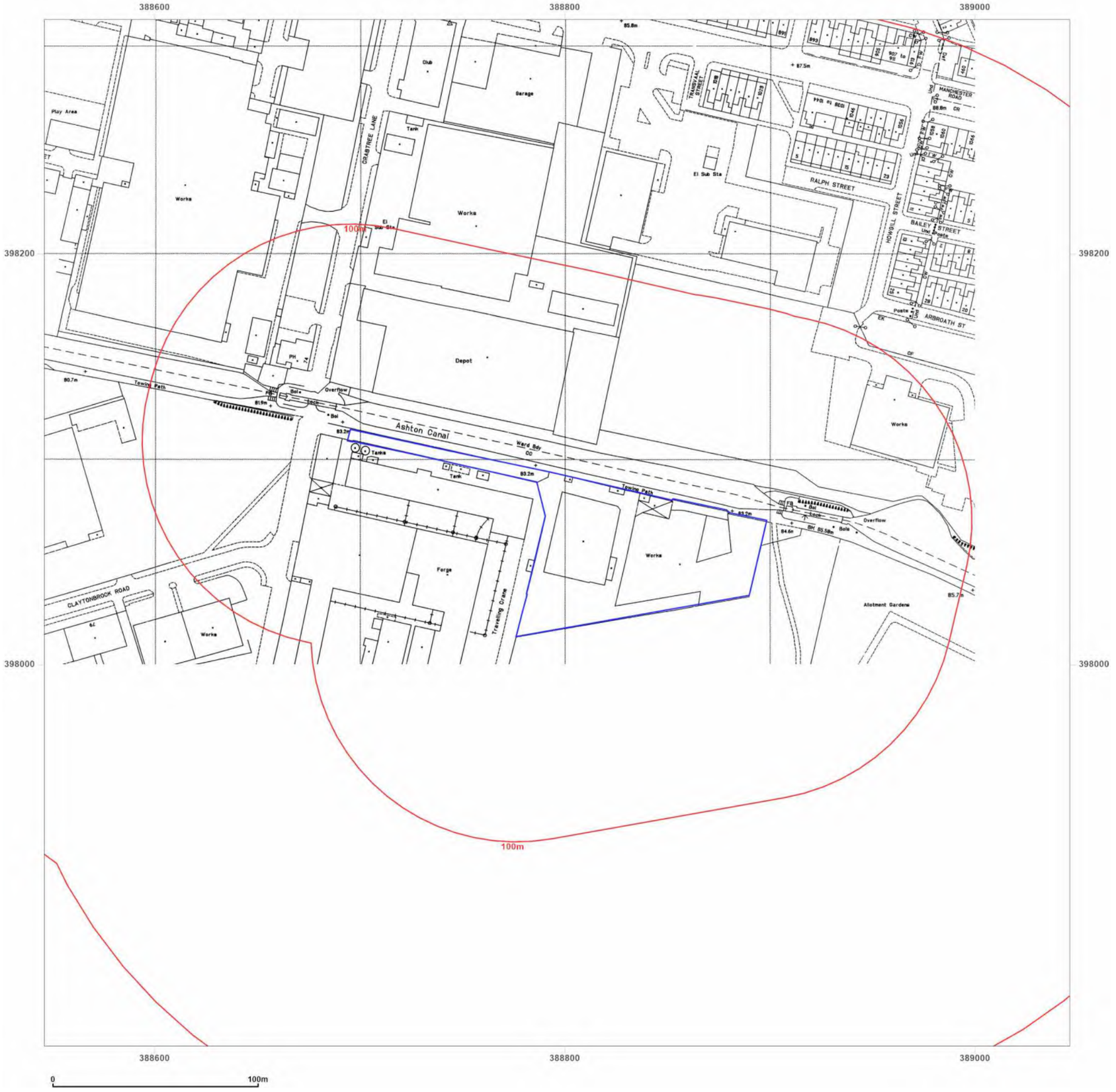
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Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

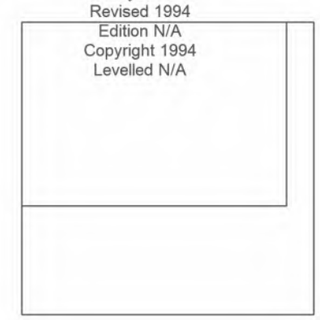
Map date: **1994**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1994
Revised 1994
Edition N/A
Copyright 1994
Levelled N/A



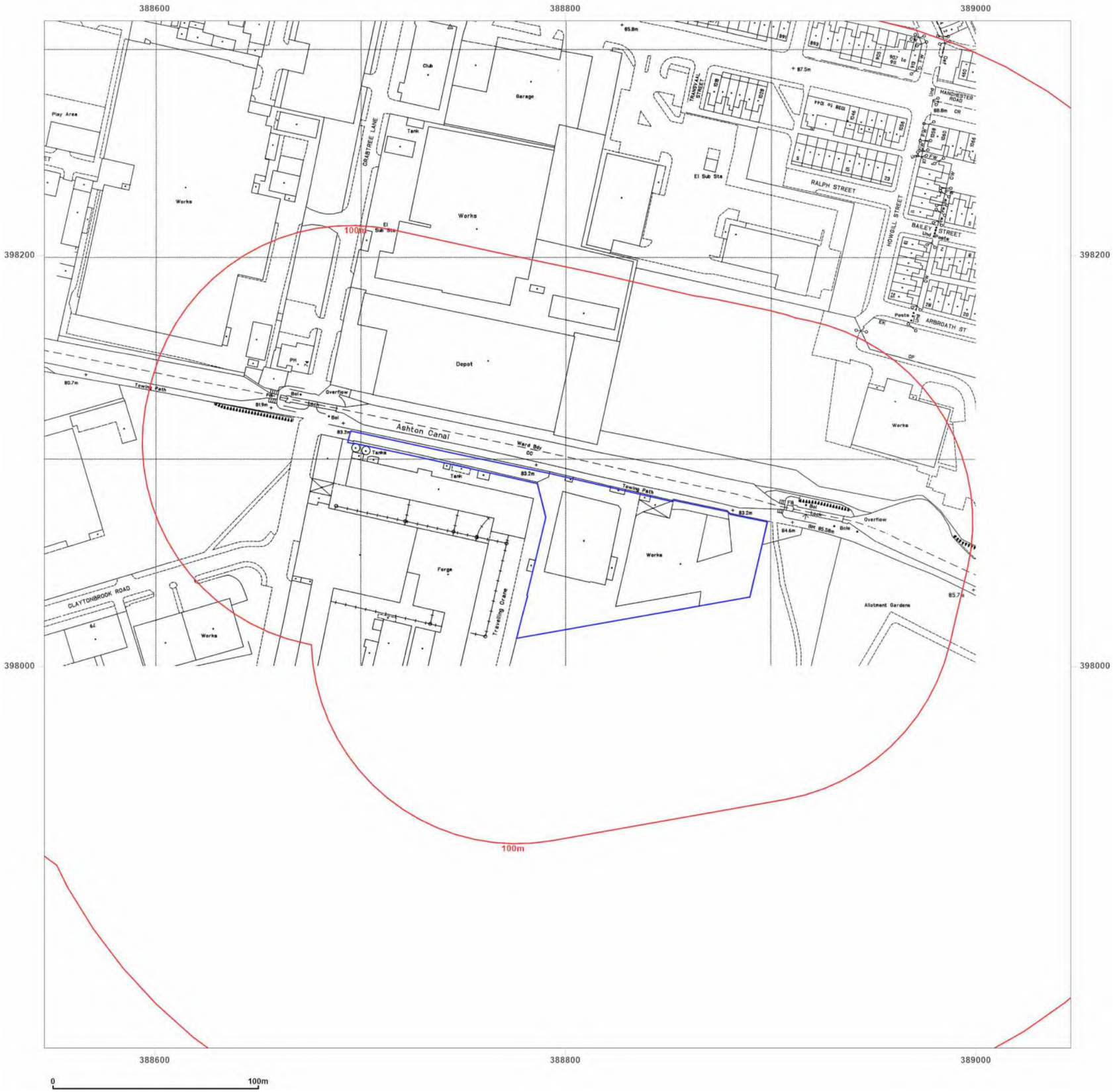
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Site Details:

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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

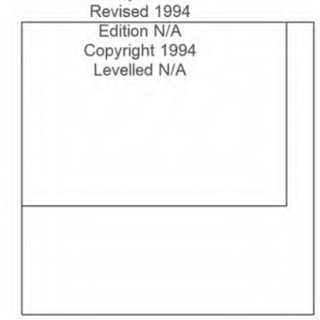
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Scale: 1:1,250

Printed at: 1:2,000

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Surveyed 1994
Revised 1994
Edition N/A
Copyright 1994
Levelled N/A



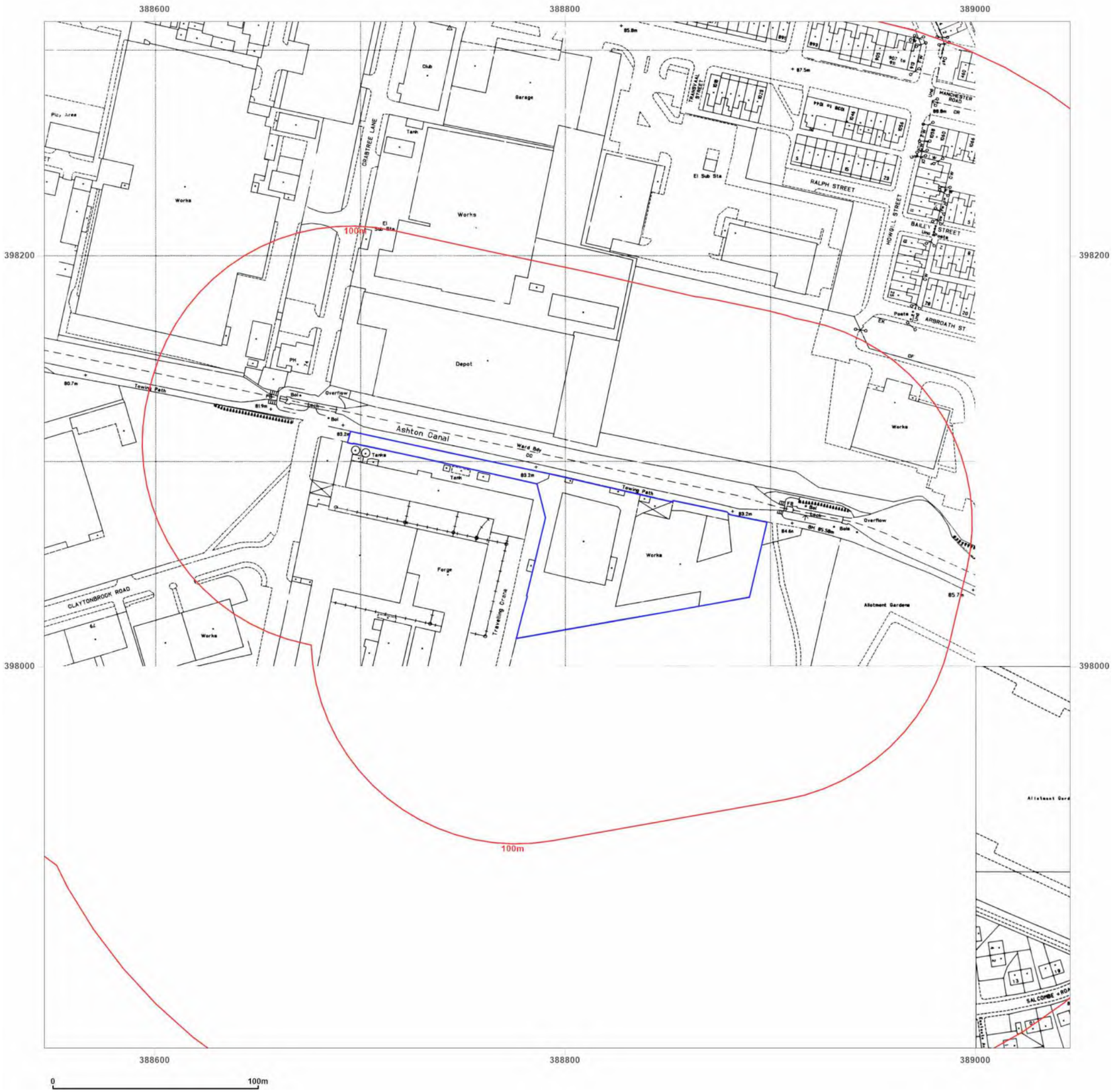
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Site Details:

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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1991-1994**

Scale: 1:1,250

Printed at: 1:2,000

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Surveyed N/A
Revised N/A
Edition N/A
Copyright 1994
Levelled N/A

Surveyed 1957
Revised 1967
Edition N/A
Copyright 1991
Levelled N/A

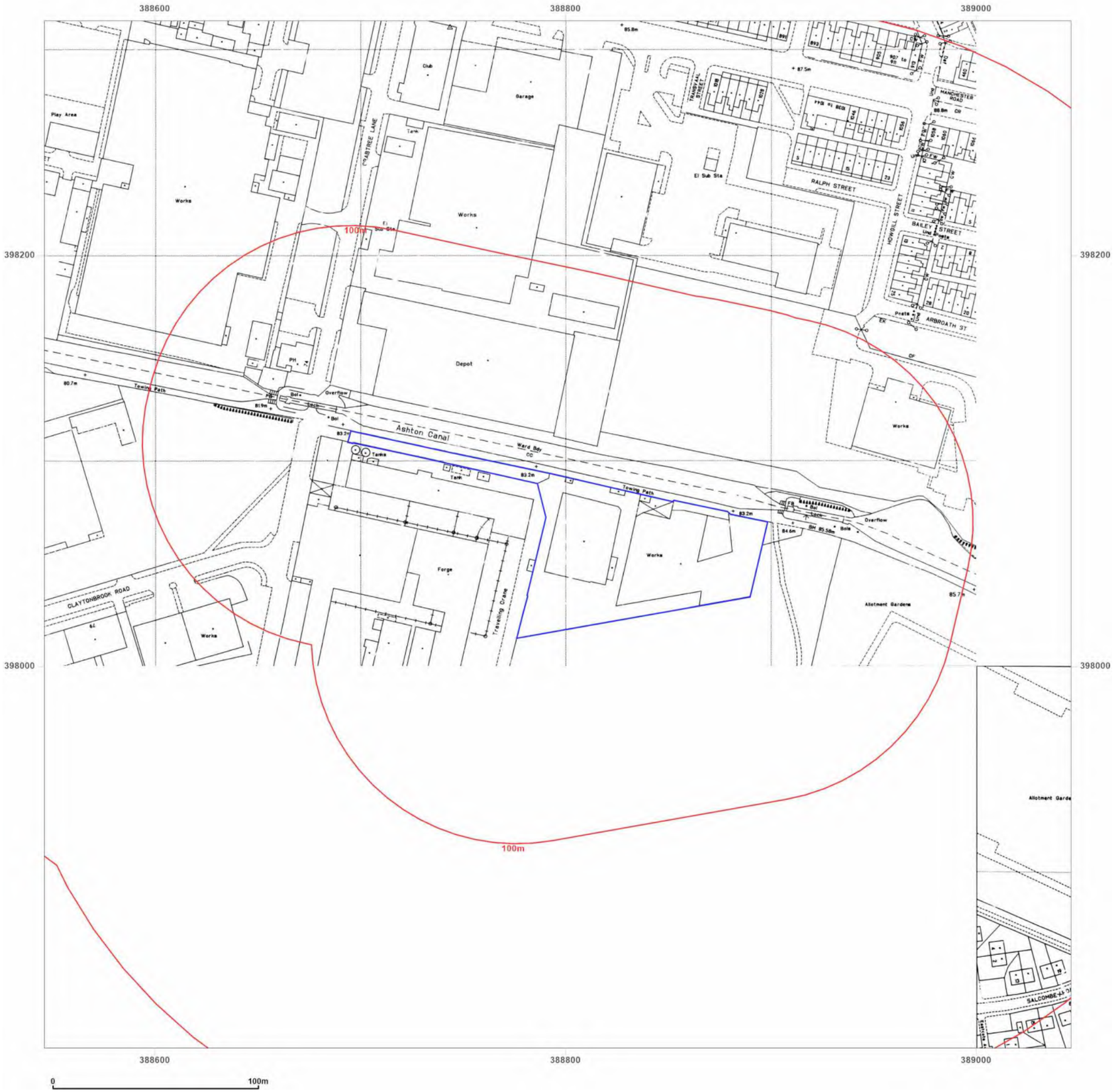
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Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: National Grid

Map date: **1992-1994**

Scale: 1:1,250

Printed at: 1:2,000

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Revised N/A
Edition N/A
Copyright 1994
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
Copyright 1992
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Site Details:

Crabtree Lane, Manchester, M11 4GU

Client Ref: 007660
Report Ref: GS-VBC-HH2-AFP-QZQ
Grid Ref: 388796, 398064

Map Name: LandLine
Map date: **2003**
Scale: 1:1,250
Printed at: 1:1,250

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APPENDIX VII
EXPLORATORY HOLE LOGS



Trial Pit Log

TrialPit No: TP101
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.60 × 0.90 Depth 2.00	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	ES					MADE GROUND: Blackish brown slightly sandy gravel. Gravel is fragments of brick, concrete, clinker, wood, and ceramic with cobbles of brick and concrete and inclusions of ash.
	1.20	B					
	1.50	HVP	78	1.40			Stiff brown slightly sandy CLAY.
	2.00	HVP	81	2.00			End of Pit at 2.00m

Remarks: 1. Complete. 2. Slight hydrocarbon odour in Made Ground. 3. What Three Words location: foal.prom.parts.

Stability: STABLE

Trial Pit Log

TrialPit No: TP102
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.60 x 0.90 Depth 2.60	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20			MADE GROUND: Concrete.
	1.50	ES					MADE GROUND: Blackish brown gravelly fine to medium sand. Gravel is fragments of concrete, brick, asphalt, ceramic, clinker, and slate with cobbles of brick and concrete and inclusions of ash.
	2.10	HVP	57	2.10			Stiff grey slightly sandy CLAY.
	2.60	HVP	59	2.60			End of Pit at 2.60m

1
2
3
4

Remarks: 1. Complete. 2. Slight hydrocarbon odour at base of Made Ground. 3. What Three Words location: spoke.tester.keep.

Stability: STABLE

Trial Pit Log

TrialPit No: TP103
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.60 x 0.90 Depth 2.70	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			MADE GROUND: Grey sandy gravel. Gravel is fragments of concrete, brick, and ceramic.
				0.30			MADE GROUND: Concrete.
	1.00	ES					MADE GROUND: Blackish brown fine to medium sand with rare fragments of brick and concrete.
	1.50	B					
				2.00			Stiff brown slightly sandy CLAY.
	2.50	HVP	110				
				2.70			End of Pit at 2.70m

Remarks: 1. Complete. 2. Brick wall at 0.4 m bgl to 1.8 m bgl. 3. What Three Words location: text.rings.snows.

Stability: STABLE

Trial Pit Log

TrialPit No: TP104
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 3.40 x 0.90 Depth 0.60	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.50	ES		0.60			MADE GROUND: Blackish brown slightly sandy gravel. Gravel is fragments of brick, concrete, asphalt, wood, metal, and fabric with cobbles of concrete and brick.
							End of Pit at 0.60m

Remarks: 1. Refused on concrete slab. 2. What Three Words location: bunny.envy.patch.

Stability: STABLE

Trial Pit Log

TrialPit No: TP105
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.80 × 0.90, Depth 2.70	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.50	ES					MADE GROUND: Blackish grey sandy gravel. Gravel is fragments of brick, asphalt, slate, concrete, ceramic, electronics, and clinker and inclusions of ash.
	0.80	B					
1.30				1.30			
	1.50	HVP	51				Firm grey slightly sandy CLAY. (Becoming stiff at 2.00m bgl).
	2.00	HVP	122				
	2.50	HVP	90				
				2.70			End of Pit at 2.70m

Remarks: 1. Complete. 2. Brick wall at 0.7 m bgl to 1.2 m bgl. 3. Water strike noted as slow ingress at 1.3 m bgl. 3. What Three Words location: plenty.shorts.cats.

Stability: STABLE

Trial Pit Log

TrialPit No: TP106
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.00 x 0.90 Depth 2.10	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50	ES		0.20			MADE GROUND: Concrete with rebar.
							MADE GROUND: Blackish brown sandy gravel. Gravel is fine to medium subangular to subrounded of sandstone with fragments of concrete, brick, and asphalt.
	1.00	HVP	124	0.70			Stiff brown slightly sandy CLAY.
	1.50	HVP	149				
				2.10			End of Pit at 2.10m

1
2
3
4

Remarks: 1. Complete. 2. What Three Words location: cases.shout.dwell.

Stability: STABLE

Trial Pit Log

TrialPit No: TP107
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.20 x 0.90 Depth 2.90	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			MADE GROUND: Asphalt.
				0.60			MADE GROUND: Concrete.
	1.20	ES					MADE GROUND: Blackish brown gravelly fine to medium sand. Gravel is fragments of brick, concrete, and ceramic.
	2.20	HVP	49	2.20			Firm blueish grey slightly sandy CLAY.
	2.70	HVP	46	2.90			End of Pit at 2.90m

Remarks: 1. Complete. 2. What Three Words location: pretty.wings.device.

Stability: STABLE

Trial Pit Log

TrialPit No: TP108
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.30 × 0.90, Depth 3.00	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			MADE GROUND: Concrete.
							MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of concrete, brick, ceramic, and clinker with cobbles of concrete and brick and inclusions of ash.
	2.20	ES					
				2.50			Stiff brown sandy CLAY with lenses of brown fine to medium sand.
	2.70	HVP	106				
				3.00			End of Pit at 3.00m

Remarks: 1. Complete. 2. Collapse at 0.8m bgl. 3. Brick wall at 0.3 m bgl to 2.2 m bgl. 3. What Three Words location: same.glue.idea.

Stability: UNSTABLE

Trial Pit Log

TrialPit No: TP109
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 1.90 × 0.90 Depth 1.70	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			MADE GROUND: Reddish brown slightly sandy gravel. Gravel is fragments of brick and concrete.
				0.30			MADE GROUND: Asphalt.
	0.50	ES					MADE GROUND: Blackish brown slightly clayey sandy gravel. Gravel is fragments of brick, concrete, and ceramic.
	0.90	HVP	117	0.80			Stiff brown slightly sandy CLAY.
	1.10	HVP	84				
	1.50	B		1.20			Brown slightly gravelly fine to medium SAND. Gravel is fine to medium subangular to subrounded of sandstone and mudstone.
				1.70			End of Pit at 1.70m

Remarks: 1. Complete. 2. Slight hydrocarbon odour in Made Ground. 3. What Three Words location: trend.years.admiral.

Stability: STABLE

Trial Pit Log

TrialPit No: TP110
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.50 x 0.90 Depth 3.20	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30			MADE GROUND: Grey sandy gravel. Gravel is fine to medium subangular to subrounded of sandstone with fragments of concrete, brick, and ceramic with cobbles of concrete.
	1.50	ES					MADE GROUND: Blackish brown gravelly fine to medium sand. Gravel is fragments of concrete, brick, ceramic, clinker, and asphalt with cobbles of brick and concrete.
				2.30			
	2.50	HVP	36				Soft grey slightly sandy CLAY. (Friable) (Becoming firm at 3.00m bgl).
	3.00	HVP	72				
				3.20			End of Pit at 3.20m

1
2
3
4

Remarks: 1. Complete. 2. Brick wall at 0.5 m bgl to 1.7 m bgl. 3. Pipe uncovered at 0.6 m bgl. 3. What Three Words location: sushi.impose.fleet.

Stability: STABLE

Trial Pit Log

TrialPit No: TP111
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.80 × 0.90, Depth 2.20	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			MADE GROUND: Concrete with rebar.
	0.80	ES					MADE GROUND: Blackish brown sandy gravel. Gravel is fine to medium subangular to subrounded of sandstone with fragments of concrete, asphalt, and brick with clods of clay.
	1.20	HVP	144				
	1.80	HVP	142	1.70			Stiff brown slightly sandy CLAY.
				2.20			End of Pit at 2.20m

1
2
3
4

Remarks: 1. Complete. 2. Boulder of concrete at 1 m bgl. 3. What Three Words location: trunk.cattle.lion.

Stability: STABLE

Trial Pit Log

TrialPit No: TP112
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.50 × 0.90 Depth 2.20	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20			MADE GROUND: Concrete with rebar.
				0.40			MADE GROUND: Blackish brown sandy gravel. Gravel is fine to medium subangular to subrounded of sandstone with fragments of brick, concrete, asphalt, and clinker.
	0.50	HVP	171				Stiff greyish brown sandy CLAY. (Friable at depth).
	1.00	HVP	139				
	1.20	ES					
	2.00	HVP	124				
				2.20			End of Pit at 2.20m

1
2
3
4

Remarks: 1. Complete. 2. Surface water ingress. 3. What Three Words location: panic.diner.sunk.

Stability: STABLE

Trial Pit Log

TrialPit No: TP113
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.50 × 0.90 Depth 2.20	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
	0.10	ES		0.10			MADE GROUND: Asphalt.
				0.20			MADE GROUND: Light brown gravel. Gravel is fine to medium subangular to subrounded of sandstone. (MOT Subbase).
							MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of brick, ceramic, concrete, asphalt, clinker, and rebar with cobbles of concrete and brick and inclusions of ash.
				2.20			End of Pit at 2.20m

1
2
3
4

Remarks: 1. Refused at collapse. 2. Collapse at 0.80m bgl. 3. What Three Words location: bought.rather.spray

Stability: UNSTABLE

Trial Pit Log

TrialPit No: TP114
Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: - Level:	Date 12/03/2024
Location: Manchester		Dimensions (m): 2.80 x 0.90 Depth 3.40	Scale 1:30
Client: Connell Brothers			Logged L. CALLISS

Water Strike	Samples & In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.20			MADE GROUND: Greyish brown slightly sandy gravel. Gravel is fragments of brick, concrete, ceramic, and plastic.
	1.00	B					MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of brick, concrete, and asphalt.
	1.50	ES					
	3.20	HVP	65	3.10			Firm grey CLAY.
				3.40			End of Pit at 3.40m

1
2
3
4

Remarks: 1. Complete. 2. Concrete obstruction at 3.1 m bgl. 3. Slight hydrocarbon odour in Made Ground. 4. What Three Words location: crab.window.civil.

Stability: STABLE

Borehole Log

Borehole No. **WS101**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.50	ES		0.80			MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of asphalt, brick, ceramic, and clinker with inclusions of ash.
		1.00		N=10 (1,1/2,2,3,3)				Medium strength stiff brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		1.00 - 1.45	D					
		1.20	ES		1.80			
		2.00		N=31 (3,4/6,7,8,10)				Medium dense brown slightly gravelly fine to medium SAND. Gravel is fine to medium subangular to subrounded of mudstone and sandstone.
		3.00		N=16 (3,3/3,4,4,5)	3.20			Medium dense brown fine to medium SAND.
		4.00		N=30 (4,5/8,7,7,8)				
		5.00		N=11 (2,3/3,2,3,3)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. 2. Water strike at 3.8 m bgl. 3. What Three Words location: joke.gain.melon.

Borehole Log

Borehole No. **WS102**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Concrete.
		1.00		N=8 (1,1/2,2,2,2)				MADE GROUND: Blackish brown gravelly fine to medium sand. Gravel is fragments of concrete, brick, and clinker with inclusions of ash.
		1.50	ES +EW					
		2.00		N=22 (3,3/4,6,6,6)				
		2.50	ES		2.30			High strength very stiff grey slightly sandy CLAY.
	▼	3.00		N=20 (3,4/5,4,5,6)				
		3.00 - 3.45	D					
		4.00		N=35 (6,7/8,9,9,9)	4.00			Medium dense brown slightly gravelly fine to medium SAND. Gravel is fine to medium subangular to subrounded of sandstone.
		5.00		N=34 (7,9/9,8,8,9)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. Water strike at 3 m bgl. 3. What Three Words location: builds.laws.piles.

Borehole Log

Borehole No. **WS103**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30	ES +EW					MADE GROUND: Blackish brown slightly gravelly sand. Gravel is fragments of brick, concrete, and slate.
		1.00		N=9 (1,2/2,2,2,3)	1.00			Medium strength stiff grey slightly sandy CLAY.
		1.50 - 2.00	U					
		2.00		N=12 (2,3/2,3,3,4)	2.00			Medium strength stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone. Becoming high strength very stiff at 3.00 m bgl.
		2.00 - 2.45	D					
		2.30	ES					
		3.00		N=30 (3,4/6,7,8,9)				
		3.00 - 3.45	D					
					3.80			Medium dense brown fine to medium SAND.
		4.00		N=16 (3,2/4,4,4,4)				
		5.00		N=16 (4,4/3,3,4,6)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. 2. What Three Words location: carbon.envy.placed.

Borehole Log

Borehole No. **WS104**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Light grey sandy gravel. Gravel is fragments of concrete, asphalt, and brick.
					0.30			MADE GROUND: Cobble of brick.
		1.00		N=6 (1,1/1,1,2,2)				MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of concrete, brick, slate, clinker, and glass with a cobble of brick at 1.2 m bgl and inclusions of ash.
		1.50	ES +EW					
		2.00		N=4 (1,2/1,1,1,1)				
		3.00		N=8 (1,1/2,2,2,2)				
	▼	4.00		N=4 (1,1/1,1,1,1)	4.00			MADE GROUND: Black fine to medium sand. (Saturated).
		4.20	ES					
					4.50			Loose brown fine to medium SAND.
		5.00		N=10 (1,2/2,2,3,3)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. Water strike at 4 m bgl. 3. Slight hydrocarbon odour in Made Ground, particularly within the saturated sand.
3. What Three Words location: proper.noisy.gentle.

Borehole Log

Borehole No. **WS105**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Concrete.
		0.80	ES					MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of concrete, brick, clinker, ceramic, and asphalt with inclusions of ash.
		1.00		N=6 (2,2/1,1,2,2)				
		1.80	ES					
		2.00		N=5 (2,1/1,2,1,1)				
					2.50			Medium strength stiff grey slightly gravelly slightly sandy CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		3.00		N=12 (2,3/3,3,3,3)				
		3.00 - 3.45	D					
		4.00		N=16 (3,4/4,4,4,4)				
		4.00 - 4.45	D					
					4.60			Medium dense greyish brown slightly clayey fine to medium SAND.
		5.00		N=19 (3,5/5,4,4,6)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. 2. What Three Words location: richer.edit.join.

Borehole Log

Borehole No. **WS106**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type WS
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Concrete.
		0.50 - 1.00	U					Medium strength stiff grey slightly gravelly slightly sandy CLAY. Gravel is fine to medium subangular to subrounded of mudstone. Becoming very high strength very stiff at 2.00 m bgl.
		1.00 1.00 - 1.45	D	N=13 (2,3/3,3,3,4)				
		1.60	ES					
		2.00 2.00 - 2.45	D	N=35 (2,3/3,4,12,16)				
		2.60	ES		2.50			Medium dense brown fine to medium SAND.
	▼	3.00		N=26 (5,5/6,6,7,7)				
		4.00		N=23 (2,2/2,7,7,7)				
					4.50			Medium dense brown clayey fine SAND.
		5.00		N=18 (4,4/3,4,5,6)	5.00			End of borehole at 5.00 m

Remarks

1. Complete. Water strike at 3.7 m bgl. 3. What Three Words location: faces.wonderfully.branch.

Borehole Log

Borehole No. **CP101**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type CP
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 12/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10			MADE GROUND: Concrete.
					0.40			MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of asphalt, brick, and ceramic.
		1.00 1.00 - 1.45	D	N=5 (2,1/1,1,1,2)				MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of asphalt, brick, ceramic, and clinker with inclusions of ash.
					1.20			Soft brown slightly sandy CLAY.
		2.00 2.00 2.00 - 2.45	B D	N=11 (2,2/2,3,3,3)	2.10			Medium dense brown fine to medium SAND.
		3.00 3.00 - 3.45	D	N=17 (2,3/4,4,4,5)				
		4.00 4.00 - 4.45	D	N=21 (3,4/4,5,6,6)				
		5.00 5.00 - 5.45	D	N=22 (2,3/5,5,6,6)				
	▼	6.00 - 6.45	D					
		6.50		N=21 (3,4/4,5,5,7)				
		7.00 - 7.45	D		7.10			Very stiff brown slightly silty CLAY.
		7.50	B		7.30			Brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		8.00 8.00 - 8.45	D	50 (7,9/50 for 255mm)	8.20			Dense brown gravelly fine to medium SAND.
		9.50		50 (6,9/50 for 245mm)				
					10.00			End of borehole at 10.00 m

Remarks

1. Complete. 2. Water strike at 6.00 m bgl. 3. What Three Words location: part.span.heads.

Borehole Log

Borehole No. **CP102**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type CP
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 13/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50			MADE GROUND: Asphalt.
		1.00		0 (75 for 50mm/0 for 0mm)				MADE GROUND: Concrete.
		1.00 - 1.45	D		1.20			MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of brick, concrete, and asphalt.
		2.00	B					
		2.00		N=6 (1,2/1,1,2,2)				
		2.00 - 2.45	D		2.50			Stiff grey slightly sandy CLAY.
		3.00	B					
		3.00		N=13 (2,2/3,3,4,3)				
		3.00 - 3.45	D		3.70			Dense brown gravelly fine to medium SAND.
		4.00		N=30 (5,7/7,7,8,8)				
		4.00 - 4.45	D					
	▼	5.00	B		5.00			Medium dense brown fine to medium SAND.
		5.00		N=26 (4,5/6,6,7,7)				
		5.00 - 5.45	D					
		6.00 - 6.45	D					
		6.50		N=30 (5,5/6,7,8,9)				
		7.00 - 7.45	D		6.80			Dense brown fine to medium SAND.
		8.00		50 (6,8/50 for 265mm)				
		8.00 - 8.45	D					
		9.50		50 (6,7/50 for 245mm)				
					10.00			End of borehole at 10.00 m

Remarks

1. Complete. 2. Water strike at 5.00 m bgl, rising to 4.80 m bgl after 20 minutes. What Three Words location: laptop.hint.frogs.

Borehole Log

Borehole No. **CP103**

Sheet 1 of 1

Project Name: Crabtree Lane	Project No. 17548	Co-ords: -	Hole Type CP
Location: Manchester		Level:	Scale 1:50
Client: Connell Brothers		Dates: 14/03/2024 -	Logged By L. CALLISS

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		1.00		50 (10,12/50 for 105mm)				MADE GROUND: Blackish brown sandy gravel. Gravel is fragments of asphalt, brick, and ceramic.
		1.00 - 1.45	D					
					1.80			
		2.00	B					Brown slightly sandy CLAY.
		2.00		N=14 (2,2/2,3,4,5)				
		2.00 - 2.45	D					
	▼				2.70			
		3.00		N=25 (3,4/5,6,6,8)				Medium dense brown fine to medium SAND with interbedded gravel. Gravel is fine to medium subangular to subrounded of sandstone.
		3.00 - 3.45	D					
		4.00	B		4.00			
		4.00		N=25 (4,5/5,6,7,7)				Medium dense brown gravelly fine to medium SAND.
		4.00 - 4.45	D					
		5.00		N=27 (5,5/6,7,7,7)				
		5.00 - 5.45	D					
		5.50	B		5.50			Brown slightly gravelly CLAY. Gravel is fine to medium subangular to subrounded of mudstone.
		6.00 - 6.45	D		6.00			Dense brown fine to medium SAND.
		6.50		50 (5,7/50 for 255mm)				
		7.00 - 7.45	D					
		8.00		50 (5,8/50 for 260mm)				
		8.00 - 8.45	D					
		9.50		50 (6,10/50 for 260mm)				
					10.00			End of borehole at 10.00 m

Remarks

1. Complete. 2. Water strike at 2.70 m bgl, rising to 2.60 m bgl after 20 minutes. What Three Words location: grit.blues.stable.

APPENDIX VIII
CHEMICAL TESTING RESULTS



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Business Park,
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Analytical Report Number : 24-008846

Project / Site name:	Crabtree Lane, Manchester	**Samples received on:**	13/03/2024
Your job number:	17-528	**Samples instructed on/ Analysis started on:**	14/03/2024
Your order number:	007639	**Analysis completed by:**	19/03/2024
Report Issue Number:	1	**Report issued on:**	08/04/2024
Samples Analysed:	12 soil samples - 3 leachate samples		

Signed:

Joanna Wawrzeczko
Senior Reporting Specialist
For & on behalf of i2 Analytical Ltd.

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

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

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

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

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

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

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144423	144424	144425	144426	144427
Sample Reference				WS101	WS102	WS103	WS104	WS105
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.20	1.50	0.30	1.50	2.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	16	33	38	22	20
Total mass of sample received	kg	0.1	NONE	0.4	0.4	0.4	0.4	0.4
Asbestos								
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	SPU	SPU	SCA	SPU	SCA
Actinolite detected	Type	N/A	ISO 17025	-	-	-	Not-detected	-
Amosite detected	Type	N/A	ISO 17025	-	-	-	Not-detected	-
Anthophyllite detected	Type	N/A	ISO 17025	-	-	-	Not-detected	-
Chrysotile detected	Type	N/A	ISO 17025	-	-	-	Detected	-
Crocidolite detected	Type	N/A	ISO 17025	-	-	-	Not-detected	-
Tremolite detected	Type	N/A	ISO 17025	-	-	-	Not-detected	-
Asbestos % by hand picking/weighing	%	0.001	ISO 17025	-	-	-	0.033	-
Asbestos Containing Material Types Detected (ACM)	Type	N/A	ISO 17025	-	-	-	Loose Fibres	-
General Inorganics								
pH (L099)	pH Units	N/A	MCERTS	8	8	7.6	8.4	7.3
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	1.3	1	< 1.0
Total Sulphate as SO_4	mg/kg	50	MCERTS	240	1600	4800	2200	470
Water Soluble SO_4 1hr extraction	mg/kg	2.5	MCERTS	120	150	120	730	91
Water Soluble SO_4 (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	61.6	72.8	60.7	366	45.5
Sulphide	mg/kg	1	MCERTS	< 1.0	7.1	9.2	8.4	4.4
Total Sulphur	mg/kg	50	MCERTS	110	1800	1500	1600	520
Organic Matter (automated)	%	0.1	MCERTS	-	-	10	-	-
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	0.7	5.6	5.9	7	1.6
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144423	144424	144425	144426	144427
Sample Reference				WS101	WS102	WS103	WS104	WS105
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.20	1.50	0.30	1.50	2.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	0.25	< 0.05	0.36	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	0.41	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.07	0.11	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.05	0.36	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	0.45	0.69	4	0.15
Anthracene	mg/kg	0.05	MCERTS	< 0.05	0.11	0.12	0.86	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.68	0.89	7.8	0.17
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.7	0.96	6.4	0.17
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.43	0.67	2.9	0.07
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.43	0.71	3.3	0.12
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	0.67	0.73	3.6	0.11
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	0.2	0.26	1.3	0.06
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.56	0.6	2.9	0.08
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.43	0.31	1.5	0.06
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.14	0.09	0.42	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	0.47	0.47	1.9	0.09
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	< 0.80	5.52	6.62	38.1	1.08
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.4	130	190	65	12
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	27	31	37	31	26
Copper (aqua regia extractable)	mg/kg	1	MCERTS	25	430	290	130	54
Lead (aqua regia extractable)	mg/kg	1	MCERTS	14	560	660	190	63
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.9	0.8	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	27	83	100	66	22
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	57	280	350	240	120

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144423	144424	144425	144426	144427
Sample Reference				WS101	WS102	WS103	WS104	WS105
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.20	1.50	0.30	1.50	2.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPHCWG - Aliphatic >C5 - C6 HS_1D_AL	mg/kg	0.02	NONE	-	< 0.020	< 0.020	< 0.020	< 0.020
TPHCWG - Aliphatic >C6 - C8 HS_1D_AL	mg/kg	0.02	NONE	-	< 0.020	< 0.020	< 0.020	< 0.020
TPHCWG - Aliphatic >C8 - C10 HS_1D_AL	mg/kg	0.05	NONE	-	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aliphatic >C10 - C12 EH_CU_1D_AL	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	-
TPHCWG - Aliphatic >C12 - C16 EH_CU_1D_AL	mg/kg	2	MCERTS	-	< 2.0	< 2.0	2.7	-
TPHCWG - Aliphatic >C16 - C21 EH_CU_1D_AL	mg/kg	8	MCERTS	-	< 8.0	< 8.0	27	-
TPHCWG - Aliphatic >C21 - C35 EH_CU_1D_AL	mg/kg	8	MCERTS	-	< 8.0	< 8.0	200	-
TPHCWG - Aliphatic >C5 - C35 EH_CU+HS_1D_AL	mg/kg	10	NONE	-	< 10	< 10	230	-
TPHCWG - Aromatic >EC5 - EC7 HS_1D_AR	mg/kg	0.01	NONE	-	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 HS_1D_AR	mg/kg	0.01	NONE	-	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 HS_1D_AR	mg/kg	0.05	NONE	-	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aromatic >EC10 - EC12 EH_CU_1D_AR	mg/kg	1	MCERTS	-	< 1.0	< 1.0	< 1.0	< 1.0
TPHCWG - Aromatic >EC12 - EC16 EH_CU_1D_AR	mg/kg	2	MCERTS	-	< 2.0	< 2.0	< 2.0	-
TPHCWG - Aromatic >EC16 - EC21 EH_CU_1D_AR	mg/kg	10	MCERTS	-	< 10	< 10	13	-
TPHCWG - Aromatic >EC21 - EC35 EH_CU_1D_AR	mg/kg	10	MCERTS	-	< 10	< 10	270	-
TPHCWG - Aromatic >EC5 - EC35 EH_CU+HS_1D_AR	mg/kg	10	NONE	-	< 10	< 10	280	-
TPH (>C5 - C10) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-	-	-	< 1.0
TPH (>C5 - C6) HS_1D_TOTAL	mg/kg	0.1	NONE	< 0.1	-	-	-	< 0.1
TPH (>C6 - C8) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-	-	-	< 1.0
TPH (>C8 - C10) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-	-	-	< 1.0
TPH (>C10 - C12) EH_CU_1D_TOTAL	mg/kg	2	MCERTS	< 2.0	-	-	-	< 2.0
TPH (>C12 - C16) EH_CU_1D_TOTAL	mg/kg	4	MCERTS	< 4.0	-	-	-	< 4.0
TPH (>C16 - C21) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	42	-	-	-	< 10
TPH (>C21 - C35) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	140	-	-	-	< 10
TPH (>C35 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	< 10	-	-	-	< 10
TPH Total >C5 - C40 EH_CU+HS_1D_TOTAL	mg/kg	10	NONE	190	-	-	-	< 10
TPH (C10 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	190	-	-	-	< 10
VOCs								
Chloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichlorofluoromethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trans 1,2-dichloroethylene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2,2-Dichloropropane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroform	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,1-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Cis-1,2-dichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbontetrachloride	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144423	144424	144425	144426	144427
Sample Reference				WS101	WS102	WS103	WS104	WS105
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.20	1.50	0.30	1.50	2.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
1,2-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Dibromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromodichloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Cis-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trans-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Dibromochloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Tetrachloroethene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dibromoethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,1,2-Tetrachloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
p & m-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Styrene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromoform	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Isopropylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2,2-Tetrachloroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromobenzene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
n-Propylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3,5-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
tert-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,4-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
sec-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
p-Isopropyltoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,4-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Butylbenzene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dibromo-3-chloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,4-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Hexachlorobutadiene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,3-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

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

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144428	144429	144430	144431	144432
Sample Reference				TP101	TP102	TP103	TP108	TP111
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.50	1.00	2.20	0.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	13	21	17	19	20
Total mass of sample received	kg	0.1	NONE	0.4	0.3	0.4	0.4	0.4
Asbestos								
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	SCA	SCA	SCA	IZJ	IZJ
Actinolite detected	Type	N/A	ISO 17025	-	-	-	-	-
Amosite detected	Type	N/A	ISO 17025	-	-	-	-	-
Anthophyllite detected	Type	N/A	ISO 17025	-	-	-	-	-
Chrysotile detected	Type	N/A	ISO 17025	-	-	-	-	-
Crocidolite detected	Type	N/A	ISO 17025	-	-	-	-	-
Tremolite detected	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos % by hand picking/weighing	%	0.001	ISO 17025	-	-	-	-	-
Asbestos Containing Material Types Detected (ACM)	Type	N/A	ISO 17025	-	-	-	-	-
General Inorganics								
pH (L099)	pH Units	N/A	MCERTS	6.8	7.2	7.5	7.4	7.9
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	16
Total Sulphate as SO_4	mg/kg	50	MCERTS	2000	1600	4100	1100	1500
Water Soluble SO_4 1hr extraction	mg/kg	2.5	MCERTS	160	510	3600	230	400
Water Soluble SO_4 (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	80.5	255	1810	116	199
Sulphide	mg/kg	1	MCERTS	12	14	3.4	23	4.6
Total Sulphur	mg/kg	50	MCERTS	1200	1100	1600	790	820
Organic Matter (automated)	%	0.1	MCERTS	-	5.3	-	-	-
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	2.8	3.1	2.5	2.5	2.4
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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The results included within the report relate only to the sample(s) submitted for testing.

Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144428	144429	144430	144431	144432
Sample Reference				TP101	TP102	TP103	TP108	TP111
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.50	1.00	2.20	0.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.24	1.1	0.17	0.12	0.47
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	0.17	< 0.05	< 0.05	0.09
Acenaphthene	mg/kg	0.05	MCERTS	0.13	1.6	< 0.05	< 0.05	1.4
Fluorene	mg/kg	0.05	MCERTS	0.08	1.3	< 0.05	< 0.05	0.7
Phenanthrene	mg/kg	0.05	MCERTS	1.3	14	0.27	0.39	9.5
Anthracene	mg/kg	0.05	MCERTS	0.15	3.3	< 0.05	0.05	1.9
Fluoranthene	mg/kg	0.05	MCERTS	1.2	16	0.26	0.7	12
Pyrene	mg/kg	0.05	MCERTS	1.2	16	0.29	0.78	11
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.6	6.6	0.16	0.38	5.4
Chrysene	mg/kg	0.05	MCERTS	0.75	7	0.25	0.63	4.8
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	0.66	7	0.2	0.53	5.8
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	0.27	2.7	0.09	0.29	2.1
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.54	6.6	0.17	0.5	5
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.32	3.1	0.1	0.28	2.4
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.1	0.86	< 0.05	0.08	0.69
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.44	3.8	0.17	0.38	2.7
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	8	91.4	2.13	5.11	65.5
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	34	49	55	62	46
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	1.9	< 0.2	< 0.2	< 0.2	11
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	36	31	19	29	39
Copper (aqua regia extractable)	mg/kg	1	MCERTS	1300	130	110	230	720
Lead (aqua regia extractable)	mg/kg	1	MCERTS	960	220	390	370	2100
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.5	0.5	0.4	0.4
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	41	40	37	42	46
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	890	160	260	250	3500

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144428	144429	144430	144431	144432
Sample Reference				TP101	TP102	TP103	TP108	TP111
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.50	1.00	2.20	0.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPHCWG - Aliphatic >C5 - C6 HS_1D_AL	mg/kg	0.02	NONE	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
TPHCWG - Aliphatic >C6 - C8 HS_1D_AL	mg/kg	0.02	NONE	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
TPHCWG - Aliphatic >C8 - C10 HS_1D_AL	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aliphatic >C10 - C12 EH_CU_1D_AL	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPHCWG - Aliphatic >C12 - C16 EH_CU_1D_AL	mg/kg	2	MCERTS	< 2.0	3.1	< 2.0	< 2.0	< 2.0
TPHCWG - Aliphatic >C16 - C21 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	13	< 8.0	< 8.0	8.2
TPHCWG - Aliphatic >C21 - C35 EH_CU_1D_AL	mg/kg	8	MCERTS	< 8.0	11	< 8.0	< 8.0	91
TPHCWG - Aliphatic >C5 - C35 EH_CU+HS_1D_AL	mg/kg	10	NONE	< 10	27	< 10	< 10	99
TPHCWG - Aromatic >EC5 - EC7 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 HS_1D_AR	mg/kg	0.05	NONE	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
TPHCWG - Aromatic >EC10 - EC12 EH_CU_1D_AR	mg/kg	1	MCERTS	< 1.0	2	< 1.0	< 1.0	1.5
TPHCWG - Aromatic >EC12 - EC16 EH_CU_1D_AR	mg/kg	2	MCERTS	< 2.0	8.5	< 2.0	< 2.0	5
TPHCWG - Aromatic >EC16 - EC21 EH_CU_1D_AR	mg/kg	10	MCERTS	< 10	38	< 10	< 10	28
TPHCWG - Aromatic >EC21 - EC35 EH_CU_1D_AR	mg/kg	10	MCERTS	< 10	33	< 10	< 10	62
TPHCWG - Aromatic >EC5 - EC35 EH_CU+HS_1D_AR	mg/kg	10	NONE	< 10	82	< 10	< 10	96
TPH (>C5 - C10) HS_1D_TOTAL	mg/kg	1	NONE	-	-	-	-	-
TPH (>C5 - C6) HS_1D_TOTAL	mg/kg	0.1	NONE	-	-	-	-	-
TPH (>C6 - C8) HS_1D_TOTAL	mg/kg	1	NONE	-	-	-	-	-
TPH (>C8 - C10) HS_1D_TOTAL	mg/kg	1	NONE	-	-	-	-	-
TPH (>C10 - C12) EH_CU_1D_TOTAL	mg/kg	2	MCERTS	-	-	-	-	-
TPH (>C12 - C16) EH_CU_1D_TOTAL	mg/kg	4	MCERTS	-	-	-	-	-
TPH (>C16 - C21) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
TPH (>C21 - C35) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
TPH (>C35 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
TPH Total >C5 - C40 EH_CU+HS_1D_TOTAL	mg/kg	10	NONE	-	-	-	-	-
TPH (C10 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	-	-	-	-	-
VOCs								
Chloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichlorofluoromethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trans 1,2-dichloroethylene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2,2-Dichloropropane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroform	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,1-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Cis-1,2-dichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbontetrachloride	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144428	144429	144430	144431	144432
Sample Reference				TP101	TP102	TP103	TP108	TP111
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	1.50	1.00	2.20	0.80
Date Sampled				12/03/2024	12/03/2024	12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
1,2-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Dibromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromodichloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Cis-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trans-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Dibromochloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Tetrachloroethene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dibromoethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,1,2-Tetrachloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
p & m-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Styrene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromoform	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Isopropylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1,2,2-Tetrachloroethane	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Bromobenzene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
n-Propylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3,5-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
tert-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,4-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
sec-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,3-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
p-Isopropyltoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,4-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Butylbenzene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dibromo-3-chloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,4-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Hexachlorobutadiene	µg/kg	5	NONE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2,3-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

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

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144433	144434
Sample Reference				TP112	TP114
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	1.50
Date Sampled				12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	17	22
Total mass of sample received	kg	0.1	NONE	0.4	0.4

Asbestos

Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	IZJ	IZJ
Actinolite detected	Type	N/A	ISO 17025	-	-
Amosite detected	Type	N/A	ISO 17025	-	-
Anthophyllite detected	Type	N/A	ISO 17025	-	-
Chrysotile detected	Type	N/A	ISO 17025	-	-
Crocidolite detected	Type	N/A	ISO 17025	-	-
Tremolite detected	Type	N/A	ISO 17025	-	-
Asbestos % by hand picking/weighing	%	0.001	ISO 17025	-	-
Asbestos Containing Material Types Detected (ACM)	Type	N/A	ISO 17025	-	-

General Inorganics

pH (L099)	pH Units	N/A	MCERTS	7.9	7.6
Total Cyanide	mg/kg	1	MCERTS	< 1.0	3.7
Total Sulphate as SO_4	mg/kg	50	MCERTS	400	1800
Water Soluble SO_4 1hr extraction	mg/kg	2.5	MCERTS	160	430
Water Soluble SO_4 (2:1 Leach. Equiv.) 1hr extraction	mg/l	1.25	MCERTS	78.3	217
Sulphide	mg/kg	1	MCERTS	< 1.0	8.5
Total Sulphur	mg/kg	50	MCERTS	200	2600
Organic Matter (automated)	%	0.1	MCERTS	-	-
Total Organic Carbon (TOC) - Automated	%	0.1	MCERTS	1	4.8

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144433	144434
Sample Reference				TP112	TP114
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	1.50
Date Sampled				12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Speciated PAHs					
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	0.24
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	0.14
Fluorene	mg/kg	0.05	MCERTS	< 0.05	0.1
Phenanthrene	mg/kg	0.05	MCERTS	0.27	1.5
Anthracene	mg/kg	0.05	MCERTS	0.06	0.28
Fluoranthene	mg/kg	0.05	MCERTS	0.49	2.3
Pyrene	mg/kg	0.05	MCERTS	0.43	2.5
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.24	1.2
Chrysene	mg/kg	0.05	MCERTS	0.31	1.4
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	0.3	1.4
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	0.11	0.58
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.24	1.2
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.13	0.71
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.16	0.91
Total PAH					
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	2.74	14.4
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	11	52
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	5.5
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	34
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	33	120
Copper (aqua regia extractable)	mg/kg	1	MCERTS	38	380
Lead (aqua regia extractable)	mg/kg	1	MCERTS	42	1200
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	36	49
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	96	4800

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144433	144434
Sample Reference				TP112	TP114
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	1.50
Date Sampled				12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
Petroleum Hydrocarbons					
TPHCWG - Aliphatic >C5 - C6 HS_1D_AL	mg/kg	0.02	NONE	< 0.020	< 0.020
TPHCWG - Aliphatic >C6 - C8 HS_1D_AL	mg/kg	0.02	NONE	< 0.020	< 0.020
TPHCWG - Aliphatic >C8 - C10 HS_1D_AL	mg/kg	0.05	NONE	< 0.050	< 0.050
TPHCWG - Aliphatic >C10 - C12 EH_CU_1D_AL	mg/kg	1	MCERTS	-	< 1.0
TPHCWG - Aliphatic >C12 - C16 EH_CU_1D_AL	mg/kg	2	MCERTS	-	3.3
TPHCWG - Aliphatic >C16 - C21 EH_CU_1D_AL	mg/kg	8	MCERTS	-	17
TPHCWG - Aliphatic >C21 - C35 EH_CU_1D_AL	mg/kg	8	MCERTS	-	190
TPHCWG - Aliphatic >C5 - C35 EH_CU+HS_1D_AL	mg/kg	10	NONE	-	210
TPHCWG - Aromatic >EC5 - EC7 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 HS_1D_AR	mg/kg	0.01	NONE	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 HS_1D_AR	mg/kg	0.05	NONE	< 0.050	< 0.050
TPHCWG - Aromatic >EC10 - EC12 EH_CU_1D_AR	mg/kg	1	MCERTS	< 1.0	< 1.0
TPHCWG - Aromatic >EC12 - EC16 EH_CU_1D_AR	mg/kg	2	MCERTS	-	< 2.0
TPHCWG - Aromatic >EC16 - EC21 EH_CU_1D_AR	mg/kg	10	MCERTS	-	16
TPHCWG - Aromatic >EC21 - EC35 EH_CU_1D_AR	mg/kg	10	MCERTS	-	250
TPHCWG - Aromatic >EC5 - EC35 EH_CU+HS_1D_AR	mg/kg	10	NONE	-	260
TPH (>C5 - C10) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-
TPH (>C5 - C6) HS_1D_TOTAL	mg/kg	0.1	NONE	< 0.1	-
TPH (>C6 - C8) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-
TPH (>C8 - C10) HS_1D_TOTAL	mg/kg	1	NONE	< 1.0	-
TPH (>C10 - C12) EH_CU_1D_TOTAL	mg/kg	2	MCERTS	< 2.0	-
TPH (>C12 - C16) EH_CU_1D_TOTAL	mg/kg	4	MCERTS	< 4.0	-
TPH (>C16 - C21) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	< 10	-
TPH (>C21 - C35) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	< 10	-
TPH (>C35 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	< 10	-
TPH Total >C5 - C40 EH_CU+HS_1D_TOTAL	mg/kg	10	NONE	< 10	-
TPH (C10 - C40) EH_CU_1D_TOTAL	mg/kg	10	MCERTS	< 10	-
VOCs					
Chloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Chloroethane	µg/kg	5	NONE	< 5.0	< 5.0
Bromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Vinyl Chloride	µg/kg	5	NONE	< 5.0	< 5.0
Trichlorofluoromethane	µg/kg	5	NONE	< 5.0	< 5.0
1,1-Dichloroethene	µg/kg	5	NONE	< 5.0	< 5.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	5	NONE	< 5.0	< 5.0
Trans 1,2-dichloroethylene	µg/kg	5	NONE	< 5.0	< 5.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	NONE	< 5.0	< 5.0
1,1-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
2,2-Dichloropropane	µg/kg	5	NONE	< 5.0	< 5.0
Chloroform	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,1,1-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,2-Dichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,1-Dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Cis-1,2-dichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0
Carbontetrachloride	µg/kg	5	NONE	< 5.0	< 5.0

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Lab Sample Number				144433	144434
Sample Reference				TP112	TP114
Sample Number				None Supplied	None Supplied
Depth (m)				1.20	1.50
Date Sampled				12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
1,2-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Trichloroethene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Dibromomethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Bromodichloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Cis-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Trans-1,3-dichloropropene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0
1,1,2-Trichloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,3-Dichloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Dibromochloromethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Tetrachloroethene	µg/kg	5	NONE	< 5.0	< 5.0
1,2-Dibromoethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Chlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,1,1,2-Tetrachloroethane	µg/kg	5	ISO 17025	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0
p & m-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0
Styrene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Bromoform	µg/kg	5	NONE	< 5.0	< 5.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0
Isopropylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,1,2,2-Tetrachloroethane	µg/kg	5	NONE	< 5.0	< 5.0
Bromobenzene	µg/kg	5	NONE	< 5.0	< 5.0
n-Propylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
2-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0
4-Chlorotoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,3,5-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
tert-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,2,4-Trimethylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
sec-Butylbenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,3-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
p-Isopropyltoluene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,4-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,2-Dichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Butylbenzene	µg/kg	5	NONE	< 5.0	< 5.0
1,2-Dibromo-3-chloropropane	µg/kg	5	ISO 17025	< 5.0	< 5.0
1,2,4-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0
Hexachlorobutadiene	µg/kg	5	NONE	< 5.0	< 5.0
1,2,3-Trichlorobenzene	µg/kg	5	ISO 17025	< 5.0	< 5.0

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

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester

Your Order No: 007639

Lab Sample Number				144424	144425	144426
Sample Reference				WS102	WS103	WS104
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				1.50	0.30	1.50
Date Sampled				12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
General Inorganics						
pH (automated)	pH Units	N/A	ISO 17025	7.9	7.9	7.8
Total Cyanide (Low Level 1 µg/l)	µg/l	1	NONE	6.6	4.5	3.5
Total Phenols						
Total Phenols (monohydric) low level	µg/l	1	NONE	< 1.0	1.2	1.2
Speciated PAHs						
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	NONE	< 0.01	< 0.01	< 0.01
Total PAH						
Total EPA-16 PAHs	µg/l	0.16	NONE	< 0.16	< 0.16	< 0.16
Heavy Metals / Metalloids						
Arsenic (dissolved)	µg/l	1	ISO 17025	15	14	< 1.0
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08	< 0.08	< 0.08
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	9.1	57
Chromium (dissolved)	µg/l	0.4	ISO 17025	1.9	12	60
Copper (dissolved)	µg/l	0.7	ISO 17025	22	12	12
Lead (dissolved)	µg/l	1	ISO 17025	18	< 1.0	1.8
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5	< 0.5
Nickel (dissolved)	µg/l	0.3	ISO 17025	2.4	2.1	2.6
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0	< 4.0	< 4.0
Zinc (dissolved)	µg/l	0.4	ISO 17025	18	14	16

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester

Your Order No: 007639

Lab Sample Number				144424	144425	144426
Sample Reference				WS102	WS103	WS104
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				1.50	0.30	1.50
Date Sampled				12/03/2024	12/03/2024	12/03/2024
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Leachate Analysis)	**Units**	**Limit of detection**	**Accreditation Status**			
Petroleum Hydrocarbons						
TPH - Aliphatic >C5 - C6 $_{HS_1D_AL}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aliphatic >C6 - C8 $_{HS_1D_AL}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aliphatic >C8 - C10 $_{HS_1D_AL}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aliphatic >C10 - C12 $_{EH_1D_AL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aliphatic >C12 - C16 $_{EH_1D_AL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aliphatic >C16 - C21 $_{EH_1D_AL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aliphatic >C21 - C35 $_{EH_1D_AL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aliphatic >C5 - C35 $_{HS+EH_1D_AL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aromatic >EC5 - EC7 $_{HS_1D_AR}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aromatic >EC7 - EC8 $_{HS_1D_AR}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aromatic >EC8 - EC10 $_{EH_1D_AR_MS}$	µg/l	1	NONE	< 1.0	< 1.0	< 1.0
TPH - Aromatic >EC10 - EC12 $_{EH_1D_AR_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aromatic >EC12 - EC16 $_{EH_1D_AR_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aromatic >EC16 - EC21 $_{EH_1D_AR_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH - Aromatic >EC21 - EC35 $_{EH_1D_AR_MS}$	µg/l	10	NONE	< 10	< 10	< 10
TPH (C10 - C40) $_{EH_1D_TOTAL_MS}$	µg/l	10	NONE	< 10	< 10	< 10
VOCs						
MTBE (Methyl Tertiary Butyl Ether)	µg/l	3	NONE	< 3.0	< 3.0	< 3.0
Benzene	µg/l	3	NONE	< 3.0	< 3.0	< 3.0
Toluene	µg/l	3	NONE	< 3.0	< 3.0	< 3.0
Ethylbenzene	µg/l	3	NONE	< 3.0	< 3.0	< 3.0
p & m-xylene	µg/l	3	NONE	< 3.0	< 3.0	< 3.0
o-xylene	µg/l	3	NONE	< 3.0	< 3.0	< 3.0

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

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Analytical Report Number: 24-008846
Project / Site name: Crabtree Lane, Manchester
Your Order No: 007639

Certificate of Analysis - Asbestos Quantification

Methods:

Qualitative Analysis

The samples were analysed qualitatively for asbestos by polarising light and dispersion staining as described by the Health and Safety Executive in HSG 248.

Quantitative Analysis

The analysis was carried out using our documented in-house method A006 based on HSE Contract Research Report No: 83/1996: Development and Validation of an analytical method to determine the amount of asbestos in soils and loose aggregates (Davies et al, 1996) and HSG 248. Our method includes initial examination of the entire representative sample, then fractionation and detailed analysis of each fraction, with quantification by hand picking and weighing.

The limit of detection (reporting limit) of this method is 0.001 %.

The method has been validated using samples of at least 100 g, results for samples smaller than this should be interpreted with caution.

Both Qualitative and Quantitative Analyses are UKAS accredited.

Sample Number	Sample ID	Sample Depth (m)	Sample Weight (g)	Asbestos Containing Material Types Detected (ACM)	PLM Results	Asbestos by hand picking/weighing (%)	Total % Asbestos in Sample
144426	WS104	1.50	24.5	Loose Fibres	**Chrysotile**	0.033	**0.033**

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 24-008846
Project / Site name: Crabtree Lane, Manchester

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

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

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
144423	WS101	None Supplied	1.2	Brown clay and sand with gravel
144424	WS102	None Supplied	1.5	Brown sand with gravel
144425	WS103	None Supplied	0.3	Brown sand with gravel
144426	WS104	None Supplied	1.5	Brown sand with gravel
144427	WS105	None Supplied	2.8	Brown clay and sand with gravel
144428	TP101	None Supplied	0.2	Brown sand with gravel
144429	TP102	None Supplied	1.5	Brown sandy clay with gravel
144430	TP103	None Supplied	1	Brown sand with gravel and vegetation
144431	TP108	None Supplied	2.2	Brown sand with gravel and vegetation
144432	TP111	None Supplied	0.8	Brown sandy clay with gravel and vegetation
144433	TP112	None Supplied	1.2	Brown clay and sand with gravel and vegetation
144434	TP114	None Supplied	1.5	Brown sand with gravel

Analytical Report Number : 24-008846
Project / Site name: Crabtree Lane, Manchester

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in Soil	Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques	In-house method based on HSG 248, 2021	A001B	D	ISO 17025
Asbestos Quantification - Gravimetric	Asbestos quantification by gravimetric method - in house method based on references	HSE Report No: 83/1996, HSG 248 (2021), HSG 264 (2012) & SCA Blue Book (draft)	A006B	D	ISO 17025
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate (Walkley Black Method)	In-house method	L009B	D	MCERTS
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate (Walkley Black Method)	In-house method	L009B	D	MCERTS
Sulphide in soil	Determination of sulphide in soil by acidification and heating to liberate hydrogen sulphide, trapped in an alkaline solution then assayed by ion selective electrode	In-house method	L010	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically (up to 30°C)	In-house method	L019B	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight	In-house method based on British Standard Methods and MCERTS requirements.	L019B	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L038B	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES	In-house method	L038B	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES	In-house method	L038B	D	MCERTS
Sulphate, water soluble, in soil (1hr extraction)	Sulphate, water soluble, in soil (1hr extraction)	In-house method	L038B	D	MCERTS
Metals by ICP-OES in leachate	Determination of metals in leachate by acidification followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L039B	W	ISO 17025
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds (including PAH) in soil by extraction in dichloromethane and hexane followed by GC-MS	In-house method based on USEPA 8270	L064B	D	MCERTS
Total petroleum hydrocarbons with carbon banding by GC-MS/GC-MS HS in leachate	Determination of total petroleum hydrocarbons in leachate by GC-MS/GC-MS HS with carbon banding aliphatic and aromatic	In-house method	L070B/L088	W	NONE
Total petroleum hydrocarbons by GC-MS/GC-MS HS in leachate	Determination of total petroleum hydrocarbons in leachate by GC-MS/GC-MS HS	In-house method	L070B/L088	W	NONE
BTEX and/or Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS	In-house method based on USEPA 8260	L073B	W	MCERTS

Analytical Report Number : 24-008846
Project / Site name: Crabtree Lane, Manchester

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
BTEX and/or Volatile organic compounds in leachate	Determination of volatile organic compounds in leachate by headspace GC-MS	In-house method based on USEPA 8260	L073B	W	NONE
Total petroleum hydrocarbons with carbon banding by GC-FID/GC-MS HS in soil	Determination of total petroleum hydrocarbons in soil by GC-FID/GC-MS HS with carbon banding aliphatic and aromatic	In-house method	L076B/L088	D/W	MCERTS
Total petroleum hydrocarbons by GC-FID/GC-MS HS in soil	Determination of total petroleum hydrocarbons in soil by GC-FID/GC-MS HS	In-house method	L076B/L088	D/W	MCERTS
Hexavalent chromium in leachate	Determination of hexavalent chromium in leachate by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080	W	ISO 17025
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in NaOH and addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080	W	MCERTS
Monohydric phenols (low level) in leachate	Determination of phenols in leachate by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS
Total cyanide (low level) in leachate	Determination of total cyanide by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement	In-house method	L099	D	MCERTS
pH at 20°C in leachate (automated)	Determination of pH in leachate by electrometric measurement	In-house method	L099	W	ISO 17025
Speciated EPA-16 PAHs and/or Semi-volatile organic compounds in leachate	SVOCs and PAHs in leachate	In-house method	L102B		ISO 17025
Organic 2:1 Leachate		In-house method	L020B	W	NONE

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

Analytical Report Number : 24-008846
Project / Site name: Crabtree Lane, Manchester

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	24-10438-1
Initial Date of Issue:	19-Apr-2024
Re-Issue Details:	
Client	E3P
Client Address:	Taylor Road Trafford Park Urmston Manchester M41 7JQ
Contact(s):	Andrew Edgar
Project	E3P Suites and Rates 2023-2024

Quotation No.:	Q23-31421	**Date Received:**	05-Apr-2024
Order No.:	JOB NUMBER 17-548. PURCHASE O	**Date Instructed:**	05-Apr-2024
No. of Samples:	1		
Turnaround (Wkdays):	5	**Results Due:**	11-Apr-2024
Date Approved:	19-Apr-2024		

[redacted]

Details: David Smith, Technical Director

For details about application of accreditation to specific matrix types, please refer to the Table at the back of this report

Results - Water

Project: E3P Suites and Rates 2023-2024

Client: E3P			**Chemtest Job No.:**			24-10438
Quotation No.: Q23-31421			**Chemtest Sample ID.:**			1789052
Order No.: JOB NUMBER 17-548. PURCHASE O			Client Sample Ref.:			WS103
			Client Sample ID.:			WS103
			Sample Location:			17-548, Crabtree Lane
			Sample Type:			WATER
			Sample Sub Type:			
			Date Sampled:			26-Mar-2024
			Time Sampled:			12:45
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
pH at 20C		U	1010		4.0	7.3
Cyanide (Total) Low-Level		N	1300	mg/l	0.0050	< 0.0050
Arsenic (Dissolved)		U	1455	µg/l	0.20	1.1
Cadmium (Dissolved)		U	1455	µg/l	0.11	< 0.11
Chromium (Dissolved)		U	1455	µg/l	0.50	< 0.50
Copper (Dissolved)		U	1455	µg/l	0.50	3.8
Nickel (Dissolved)		U	1455	µg/l	0.50	2.9
Lead (Dissolved)		U	1455	µg/l	0.50	0.63
Selenium (Dissolved)		U	1455	µg/l	0.50	< 0.50
Zinc (Dissolved)		U	1455	µg/l	2.5	4.5
Mercury Low Level		U	1460	µg/l	0.010	< 0.010
Chromium (Hexavalent)		U	1490	µg/l	20	[B] < 20
Aliphatic TPH >C5-C6	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C6-C8	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C8-C10	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C10-C12	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C12-C16	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C16-C21	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C21-C35	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Aliphatic TPH >C35-C44	EH_2D_AL_#1	N	1675	µg/l	0.10	< 0.10
Total Aliphatic Hydrocarbons	EH_2D_AL_#1	N	1675	µg/l	5.0	< 5.0
Aromatic TPH >C5-C7	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C7-C8	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C8-C10	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C10-C12	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C12-C16	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C16-C21	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C21-C35	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Aromatic TPH >C35-C44	EH_2D_AR_#1	N	1675	µg/l	0.10	< 0.10
Total Aromatic Hydrocarbons	EH_2D_AR_#1	N	1675	µg/l	5.0	< 5.0
Total Petroleum Hydrocarbons	EH_2D_Total_#1	N	1675	µg/l	10	< 10
Dichlorodifluoromethane		U	1760	µg/l	1.0	< 1.0
Chloromethane		U	1760	µg/l	1.0	< 1.0
Vinyl Chloride		N	1760	µg/l	1.0	< 1.0
Bromomethane		U	1760	µg/l	5	< 5

Results - Water

Project: E3P Suites and Rates 2023-2024

Client: E3P			**Chemtest Job No.:**	24-10438
Quotation No.: Q23-31421			**Chemtest Sample ID.:**	1789052
Order No.: JOB NUMBER 17-548. PURCHASE O			Client Sample Ref.:	WS103
			Client Sample ID.:	WS103
			Sample Location:	17-548, Crabtree Lane
			Sample Type:	WATER
			Sample Sub Type:	
			Date Sampled:	26-Mar-2024
			Time Sampled:	12:45

Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
Chloroethane		U	1760	µg/l	2.0	< 2.0
Trichlorofluoromethane		U	1760	µg/l	1.0	< 1.0
1,1-Dichloroethene		U	1760	µg/l	1.0	< 1.0
Trans 1,2-Dichloroethene		U	1760	µg/l	1.0	< 1.0
1,1-Dichloroethane		U	1760	µg/l	1.0	< 1.0
cis 1,2-Dichloroethene		U	1760	µg/l	1.0	< 1.0
Bromochloromethane		U	1760	µg/l	5	< 5
Trichloromethane		U	1760	µg/l	1.0	< 1.0
1,1,1-Trichloroethane		U	1760	µg/l	1.0	< 1.0
Tetrachloromethane		U	1760	µg/l	1.0	< 1.0
1,1-Dichloropropene		U	1760	µg/l	1.0	< 1.0
Benzene		U	1760	µg/l	1.0	< 1.0
1,2-Dichloroethane		U	1760	µg/l	2.0	< 2.0
Trichloroethene		N	1760	µg/l	1.0	< 1.0
1,2-Dichloropropane		U	1760	µg/l	1.0	< 1.0
Dibromomethane		U	1760	µg/l	10	< 10
Bromodichloromethane		U	1760	µg/l	5	< 5
cis-1,3-Dichloropropene		N	1760	µg/l	10	< 10
Toluene		U	1760	µg/l	1.0	< 1.0
Trans-1,3-Dichloropropene		N	1760	µg/l	10	< 10
1,1,2-Trichloroethane		U	1760	µg/l	10	< 10
Tetrachloroethene		U	1760	µg/l	1.0	< 1.0
1,3-Dichloropropane		U	1760	µg/l	2.0	< 2.0
Dibromochloromethane		U	1760	µg/l	10	< 10
1,2-Dibromoethane		U	1760	µg/l	5	< 5
Chlorobenzene		N	1760	µg/l	1.0	< 1.0
1,1,1,2-Tetrachloroethane		U	1760	µg/l	2.0	< 2.0
Ethylbenzene		U	1760	µg/l	1.0	< 1.0
m & p-Xylene		U	1760	µg/l	1.0	< 1.0
o-Xylene		U	1760	µg/l	1.0	< 1.0
Styrene		U	1760	µg/l	1.0	< 1.0
Tribromomethane		U	1760	µg/l	1.0	< 1.0
Isopropylbenzene		U	1760	µg/l	1.0	< 1.0
Bromobenzene		U	1760	µg/l	1.0	< 1.0
1,2,3-Trichloropropane		N	1760	µg/l	50	< 50

Results - Water

Project: E3P Suites and Rates 2023-2024

Client: E3P				**Chemtest Job No.:**		24-10438
Quotation No.: Q23-31421				**Chemtest Sample ID.:**		1789052
Order No.: JOB NUMBER 17-548. PURCHASE O				Client Sample Ref.:		WS103
				Client Sample ID.:		WS103
				Sample Location:		17-548, Crabtree Lane
				Sample Type:		WATER
				Sample Sub Type:		
				Date Sampled:		26-Mar-2024
				Time Sampled:		12:45
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
N-Propylbenzene		U	1760	µg/l	1.0	< 1.0
2-Chlorotoluene		U	1760	µg/l	1.0	< 1.0
1,3,5-Trimethylbenzene		U	1760	µg/l	1.0	< 1.0
4-Chlorotoluene		U	1760	µg/l	1.0	< 1.0
Tert-Butylbenzene		U	1760	µg/l	1.0	< 1.0
1,2,4-Trimethylbenzene		U	1760	µg/l	1.0	< 1.0
Sec-Butylbenzene		U	1760	µg/l	1.0	< 1.0
1,3-Dichlorobenzene		N	1760	µg/l	1.0	< 1.0
4-Isopropyltoluene		U	1760	µg/l	1.0	< 1.0
1,4-Dichlorobenzene		U	1760	µg/l	1.0	< 1.0
N-Butylbenzene		U	1760	µg/l	1.0	< 1.0
1,2-Dichlorobenzene		U	1760	µg/l	1.0	< 1.0
1,2-Dibromo-3-Chloropropane		U	1760	µg/l	50	< 50
1,2,4-Trichlorobenzene		U	1760	µg/l	1.0	< 1.0
Hexachlorobutadiene		U	1760	µg/l	1.0	< 1.0
1,2,3-Trichlorobenzene		U	1760	µg/l	2.0	< 2.0
Methyl Tert-Butyl Ether		N	1760	µg/l	1.0	< 1.0
N-Nitrosodimethylamine		N	1790	µg/l	0.50	< 0.50
Phenol		N	1790	µg/l	0.50	< 0.50
2-Chlorophenol		N	1790	µg/l	0.50	< 0.50
Bis-(2-Chloroethyl)Ether		N	1790	µg/l	0.50	< 0.50
1,3-Dichlorobenzene		N	1790	µg/l	0.50	< 0.50
1,4-Dichlorobenzene		N	1790	µg/l	0.50	< 0.50
1,2-Dichlorobenzene		N	1790	µg/l	0.50	< 0.50
2-Methylphenol (o-Cresol)		N	1790	µg/l	0.50	< 0.50
Bis(2-Chloroisopropyl)Ether		N	1790	µg/l	0.50	< 0.50
Hexachloroethane		N	1790	µg/l	0.50	< 0.50
N-Nitrosodi-n-propylamine		N	1790	µg/l	0.50	< 0.50
4-Methylphenol		N	1790	µg/l	0.50	< 0.50
Nitrobenzene		N	1790	µg/l	0.50	< 0.50
Isophorone		N	1790	µg/l	0.50	< 0.50
2-Nitrophenol		N	1790	µg/l	0.50	< 0.50
2,4-Dimethylphenol		N	1790	µg/l	0.50	< 0.50
Bis(2-Chloroethoxy)Methane		N	1790	µg/l	0.50	< 0.50
2,4-Dichlorophenol		N	1790	µg/l	0.50	< 0.50

Results - Water

Project: E3P Suites and Rates 2023-2024

Client: E3P				**Chemtest Job No.:**		24-10438
Quotation No.: Q23-31421				**Chemtest Sample ID.:**		1789052
Order No.: JOB NUMBER 17-548. PURCHASE O				Client Sample Ref.:		WS103
				Client Sample ID.:		WS103
				Sample Location:		17-548, Crabtree Lane
				Sample Type:		WATER
				Sample Sub Type:		
				Date Sampled:		26-Mar-2024
				Time Sampled:		12:45
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
1,2,4-Trichlorobenzene		N	1790	µg/l	0.50	< 0.50
Naphthalene		N	1790	µg/l	0.50	< 0.50
4-Chloroaniline		N	1790	µg/l	0.50	< 0.50
Hexachlorobutadiene		N	1790	µg/l	0.50	< 0.50
4-Chloro-3-Methylphenol		N	1790	µg/l	0.50	< 0.50
2-Methylnaphthalene		N	1790	µg/l	0.50	< 0.50
Hexachlorocyclopentadiene		N	1790	µg/l	0.50	< 0.50
2,4,6-Trichlorophenol		N	1790	µg/l	0.50	< 0.50
2,4,5-Trichlorophenol		N	1790	µg/l	0.50	< 0.50
2-Chloronaphthalene		N	1790	µg/l	0.50	< 0.50
2-Nitroaniline		N	1790	µg/l	0.50	< 0.50
Acenaphthylene		N	1790	µg/l	0.50	< 0.50
Dimethylphthalate		N	1790	µg/l	0.50	< 0.50
2,6-Dinitrotoluene		N	1790	µg/l	0.50	< 0.50
Acenaphthene		N	1790	µg/l	0.50	< 0.50
3-Nitroaniline		N	1790	µg/l	0.50	< 0.50
Dibenzofuran		N	1790	µg/l	0.50	< 0.50
4-Chlorophenylphenylether		N	1790	µg/l	0.50	< 0.50
2,4-Dinitrotoluene		N	1790	µg/l	0.50	< 0.50
Fluorene		N	1790	µg/l	0.50	< 0.50
Diethyl Phthalate		N	1790	µg/l	0.50	< 0.50
4-Nitroaniline		N	1790	µg/l	0.50	< 0.50
2-Methyl-4,6-Dinitrophenol		N	1790	µg/l	0.50	< 0.50
Azobenzene		N	1790	µg/l	0.50	< 0.50
4-Bromophenylphenyl Ether		N	1790	µg/l	0.50	< 0.50
Hexachlorobenzene		N	1790	µg/l	0.50	< 0.50
Phenanthrene		N	1790	µg/l	0.50	< 0.50
Anthracene		N	1790	µg/l	0.50	< 0.50
Carbazole		N	1790	µg/l	0.50	< 0.50
Di-N-Butyl Phthalate		N	1790	µg/l	0.50	< 0.50
Fluoranthene		N	1790	µg/l	0.50	< 0.50
Pyrene		N	1790	µg/l	0.50	< 0.50
Butylbenzyl Phthalate		N	1790	µg/l	0.50	< 0.50
Benzo[a]anthracene		N	1790	µg/l	0.50	< 0.50
Chrysene		N	1790	µg/l	0.50	< 0.50

Results - Water

Project: E3P Suites and Rates 2023-2024

Client: E3P				**Chemtest Job No.:**		24-10438
Quotation No.: Q23-31421				**Chemtest Sample ID.:**		1789052
Order No.: JOB NUMBER 17-548. PURCHASE O				Client Sample Ref.:		WS103
				Client Sample ID.:		WS103
				Sample Location:		17-548, Crabtree Lane
				Sample Type:		WATER
				Sample Sub Type:		
				Date Sampled:		26-Mar-2024
				Time Sampled:		12:45
Determinand	**HWOL Code**	**Accred.**	**SOP**	**Units**	**LOD**	
Bis(2-Ethylhexyl)Phthalate		N	1790	µg/l	0.50	< 0.50
Di-N-Octyl Phthalate		N	1790	µg/l	0.50	< 0.50
Benzo[b]fluoranthene		N	1790	µg/l	0.50	< 0.50
Benzo[k]fluoranthene		N	1790	µg/l	0.50	< 0.50
Benzo[a]pyrene		N	1790	µg/l	0.50	< 0.50
Indeno(1,2,3-c,d)Pyrene		N	1790	µg/l	0.50	< 0.50
Dibenz(a,h)Anthracene		N	1790	µg/l	0.50	< 0.50
Benzo[g,h,i]perylene		N	1790	µg/l	0.50	< 0.50
4-Nitrophenol		N	1790	µg/l	0.50	< 0.50
Total Phenols		U	1920	mg/l	0.030	[B] < 0.030

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1789052	WS103	WS103	17-548, Crabtree Lane	26-Mar-2024	B	Coloured Winchester 500ml
1789052	WS103	WS103	17-548, Crabtree Lane	26-Mar-2024	B	EPA Vial 40ml
1789052	WS103	WS103	17-548, Crabtree Lane	26-Mar-2024	B	Plastic Bottle 1000ml

Test Methods

SOP	Title	Parameters included	Method summary	Water Accred.
1010	pH Value of Waters	pH at 20°C	pH Meter	RE PW TE TS PL DW GW
1300	Cyanides & Thiocyanate in Waters	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Continuous Flow Analysis.	
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).	RE PW PL SW DW GW
1460	Mercury low-level in Waters by AFS	Mercury	Atomic Fluorescence Spectrometry, with collimated UV source, wavelength 253.7 nm.	PL GW
1490	Hexavalent Chromium in Waters	Chromium [VI]	Automated colorimetric analysis by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.	PL GW
1675	TPH Aliphatic/Aromatic split in Waters by GC-FID(cf. Texas Method 1006 / TPH CWG)	Aliphatics: >C5–C6, >C6–C8, >C8– C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Pentane extraction / GCxGC FID detection	
1760	Volatile Organic Compounds (VOCs) in Waters by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics. (cf. USEPA Method 8260)	Automated headspace gas chromatographic (GC) analysis of water samples with mass spectrometric (MS) detection of volatile organic compounds.	PL GW
1790	Semi-Volatile Organic Compounds (SVOCs) in Waters by GC-MS	Semi-volatile organic compounds	Solvent extraction / GCMS detection	
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.	PL GW

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

Water Sample Category Key for Accreditation

DW - Drinking Water
GW - Ground Water
LE - Land Leachate
NA - Not Applicable
PL - Prepared Leachate
PW - Processed Water

Report Information

RE - Recreational Water
SA - Saline Water
SW - Surface Water
TE - Treated Effluent
TS - Treated Sewage
UL - Unspecified Liquid

Clean Up Codes

NC - No Clean Up
MC - Mathematical Clean Up
FC - Florisil Clean Up

HWOL Acronym System

HS - Headspace analysis
EH - Extractable hydrocarbons – i.e. everything extracted by the solvent
CU - Clean-up – e.g. by Florisil, silica gel
1D - GC – Single coil gas chromatography
Total - Aliphatics & Aromatics
AL - Aliphatics only
AR - Aromatic only
2D - GC-GC – Double coil gas chromatography
#1 - EH_2D_Total but with humics mathematically subtracted
#2 - EH_2D_Total but with fatty acids mathematically subtracted
+ - Operator to indicate cumulative e.g. EH+EH_Total or EH_CU+HS_Total

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX IX
GEOTECHNICAL TESTING RESULTS



LABORATORY REPORT

Contract Number: PSL24/2110

Report Date: 10 April 2024

Client's Reference:

Client Name: E3P
Taylor Road
Urmston
Manchester
M41 7JQ

For the attention of: Luke Calliss

Contract Title: Crabtree Lane, Manchester

Date Received: 22/3/2024
Date Commenced: 22/3/2024
Date Completed: 10/4/2024

Notes: Opinions and Interpretations are outside the UKAS Accreditation

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[redacted]

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
1	WS101		1.00	1.45	Brown slightly gravelly very sandy CLAY.
3	WS103		2.00	2.45	Brown sandy CLAY.
5	WS106		1.00	1.45	Brown sandy CLAY.
5	WS106		0.50	1.00	Firm brown slightly gravelly very sandy CLAY.
19	CP101		2.00		Brown gravelly slightly clayey silty SAND.
22	CP102		2.00	2.45	Brown very gravelly sandy CLAY.
23	CP103		2.00	2.45	Brown slightly gravelly sandy CLAY.

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
1	WS101		1.00	1.45	20			35	18	17	98	Intermediate Plasticity CI
3	WS103		2.00	2.45	23			51	23	28	100	High Plasticity CH
5	WS106		1.00	1.45	18			42	20	22	100	Intermediate Plasticity CI
22	CP102		2.00	2.45	31			48	23	25	67	Intermediate Plasticity CI
23	CP103		2.00	2.45	18			37	19	18	96	Intermediate Plasticity CI

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY

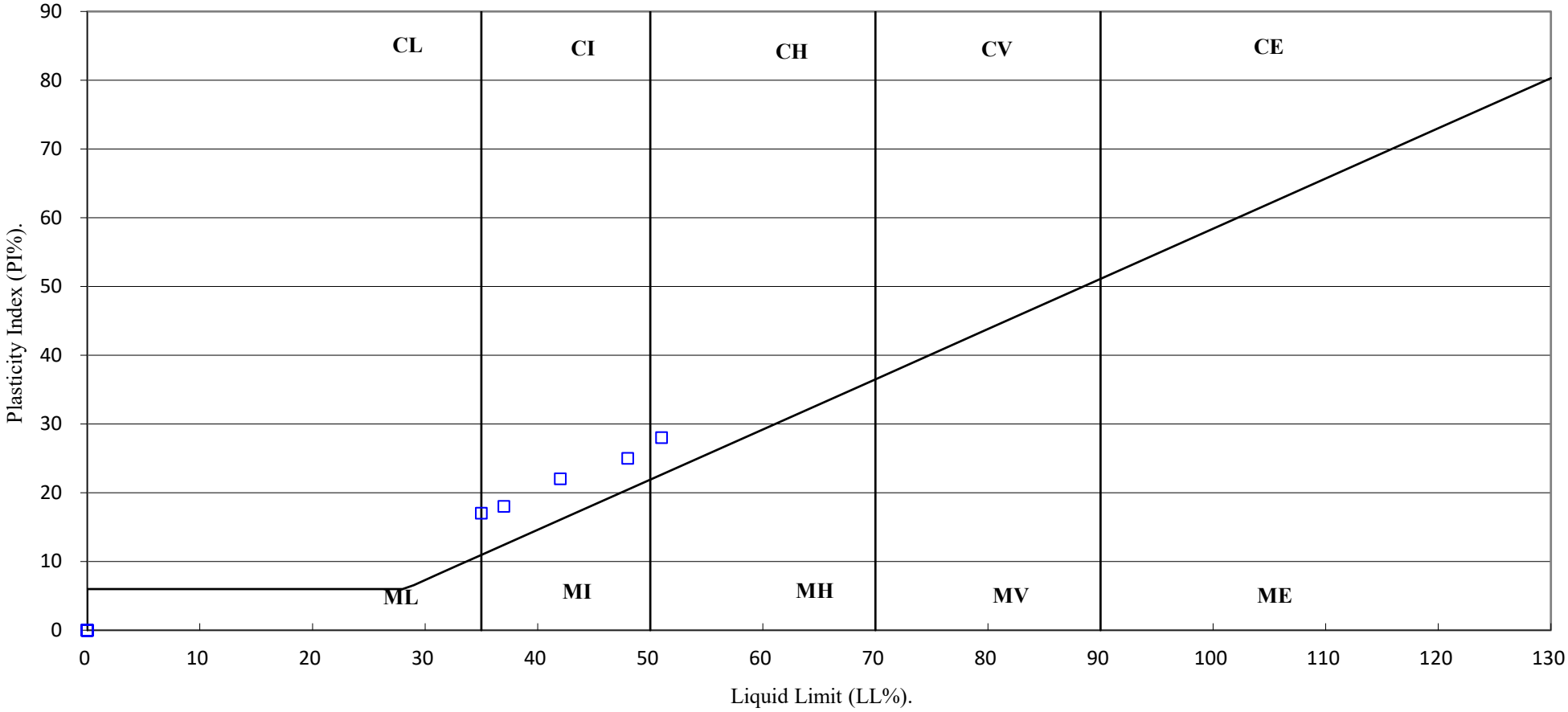
Crabtree Lane, Manchester

Contract No:

PSL24/2110

Client Ref:

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



UKAS TESTING 4043 / PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY	Crabtree Lane, Manchester	Contract No: PSL24/2110 Client Ref:

PARTICLE SIZE DISTRIBUTION TEST

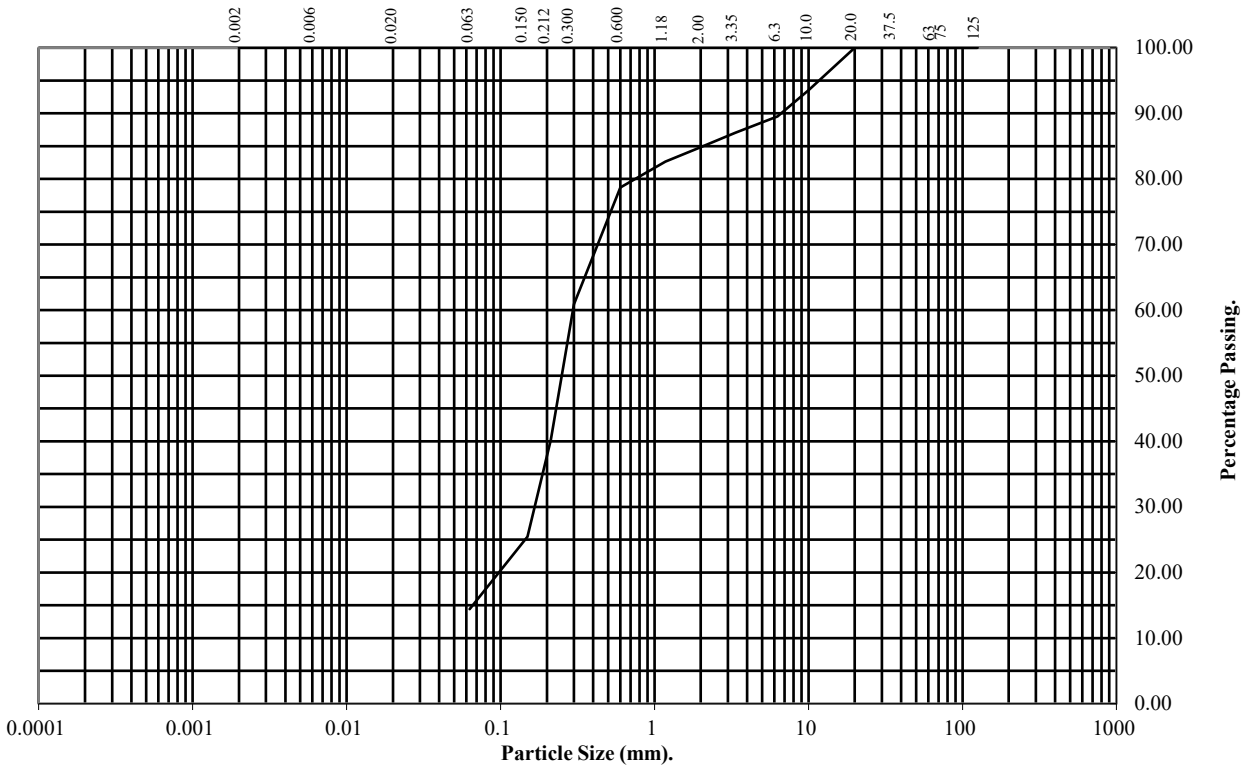
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: 19 **Top Depth (m):** 2.00

Sample Number: CP101 **Base Depth(m):**

Sample Type:



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	100
10	94
6.3	90
3.35	87
2	85
1.18	83
0.6	79
0.3	61
0.212	40
0.15	25
0.063	14

Soil Fraction	Total Percentage
Cobbles	0
Gravel	15
Sand	71
Silt/Clay	14

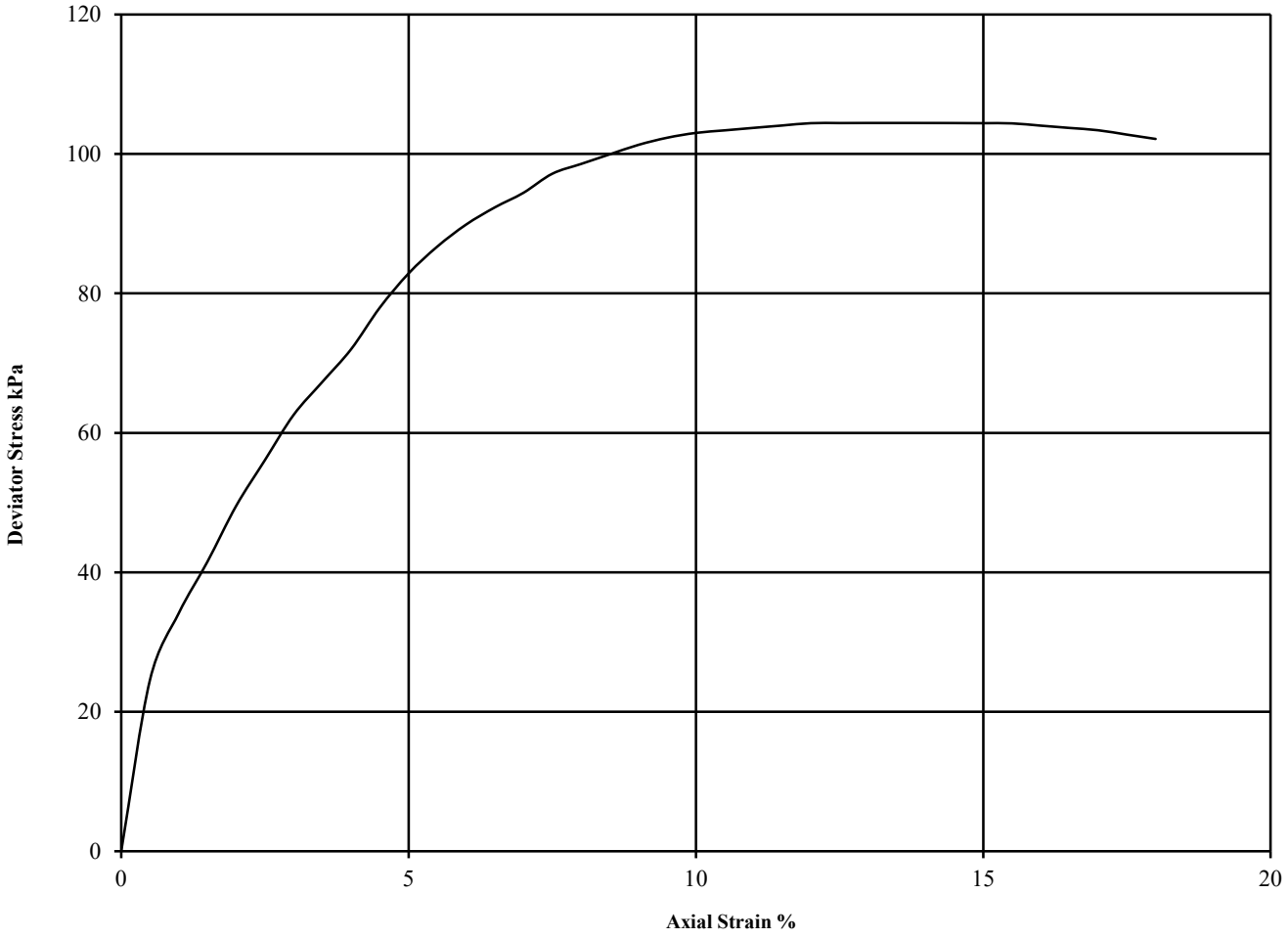
Remarks:
See Summary of Soil Descriptions

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**5**	**Top Depth (m):**	**0.50**
Sample Number:	**WS106**	**Base Depth (m):**	**1.00**
Sample Type	**U**		



Diameter (mm):		80	Height (mm):		160	Test:	UU Single Stage		Remarks:
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.43
1	15	2.21	1.93	15	104	52	13.5	Plastic	See summary of soil descriptions

UKAS TESTING 4043

PSL PROFESSIONAL SOILS LABORATORY A PHENNA GROUP COMPANY

Crabtree Lane, Manchester

Contract No: PSL24/2110

Client Ref:

APPENDIX X
ORIGIN OF CHEMICAL ASSESSMENT CRITERIA



CONSTITUENT	ORIGIN OF RISK ASSESSMENT VALUE
Arsenic	2014 LQM/CIEH S4ULs
Cadmium	2014 LQM/CIEH S4ULs
Chromium	2014 LQM/CIEH S4ULs
Lead	2014 LQM/CIEH S4ULs
Mercury	2014 LQM/CIEH S4ULs – methylmercury
Nickel	2014 LQM/CIEH S4ULs
Selenium	2014 LQM/CIEH S4ULs
Copper	2014 LQM/CIEH S4ULs
Zinc	2014 LQM/CIEH S4ULs
Cyanide – Total	2014 LQM/CIEH S4ULs
Phenols – Total	2014 LQM/CIEH S4ULs
Naphthalene	General assessment criteria (GAC) developed by CIEH/LQM Suitable 4 Use Levels with supporting data from SR3, SR7 and existing Tox report where applicable. 1% SOM.
Acenaphthylene	
Acenaphthene	
Fluorene	
Phenanthrene	
Anthracene	
Fluoranthene	
Pyrene	
Benzo(a)Anthracene	
Chrysene	
Benzo(b/k)Fluoranthene (iii)	
Benzo(a)Pyrene	
Indeno(123-cd)Pyrene	
Dibenzo(a,h)Anthracene	
Benzo(ghi)Perylene	
TPH C_5-C_6 (aliphatic)	
TPH C_6-C_8 (aliphatic)	
TPH C_8-C_{10} (aliphatic)	
TPH C_{10}-C_{12} (aliphatic)	
TPH C_{12}-C_{16} (aromatic)	
TPH C_{16}-C_{21} (aromatic)	
TPH C_{21}-C_{35} (aromatic)	

APPENDIX XI
UXO THREAT ASSESSMENT



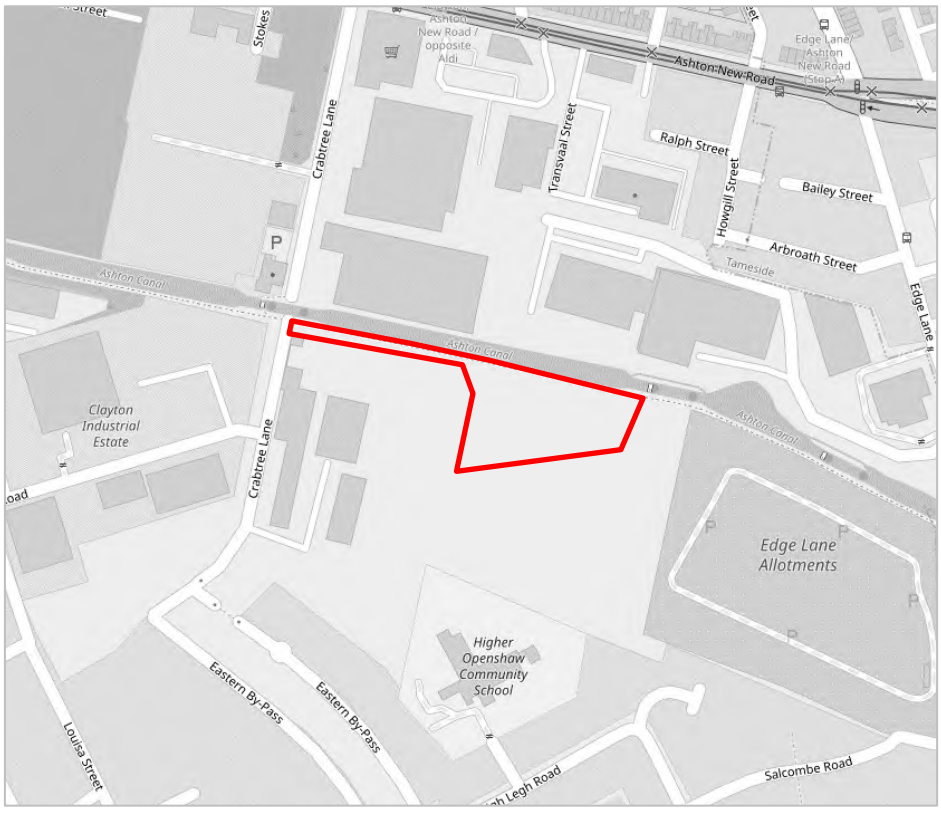


BRIMSTONE

DETAILED UXO RISK ASSESSMENT

STAGE 2 DETAILED UXO RISK ASSESSMENT

Client:	E3P Consulting		
Project Ref:	E3PL206R		
Site Name:	Crabtree Lane, Manchester		
Report Ref:	DRA-24-1690-E3PL206R-CrabtreeLane,Manchester		
Revision:	0		
Status:	Final		
Date:	17th April 2024		
Author:	Will Slack	Project Researcher	[redacted]
Reviewed By:	Chris Birch	Research Training Coordinator	
Authorised By:	Aaron Florence	Managing Director	



EXECUTIVE SUMMARY

RESULT: Brimstone concludes that UXO poses a **MODERATE RISK** to the proposed works.

THE SITE: The Site (centred on the National Grid Ref: SJ 88784 98091) is located in Clayton, within Manchester, approximately 1.1km north-west of Gorton station. The Site is bound to the north by the Manchester and Ashton under Lyme canal, to the east and south by mature vegetation, and to the west by Crabtree Lane. The Site comprises an area of open, brownfield land. It appears to be utilised for the storage of raw building materials, and multiple shipping containers are visible in the north.

THE PROPOSED WORKS: Development works on site will be residential. Whilst the Site layout isn't confirmed at the time of writing, it is likely to comprise low-rise residential properties in the centre and south, with three high-rise apartment blocks broadly spaced along the northern boundary with the canal. At the time of writing, Brimstone was not aware of any planned SI works taking place on Site.

UXO RISK ASSESSMENT:

German UXO:

- Greater Manchester was the 11th most heavily bombed British conurbation during WWII. Like today, the Site occupied an area on the periphery of the city centre during the Blitz. Analysis of Luftwaffe target mapping indicates that Gorton Locomotive Works, approximately 690m south of the Site, and North Street Works, approximately 600m west of the Site, were identified as primary targets. However, the industrial structures present on Site and in the immediate surrounds may have been identified as targets of opportunity.
- Indeed, one 'fire bomb' is recorded within the Site boundary on a bomb plot and damage map for Manchester, with a further four within an approximate 500m radius. The large industrial structure on Site is hatched in red in this source, indicating that it experienced moderate bomb damage during WWII. At some point during WWII, however, this building appears to have been cleared, as evidenced by post-WWII aerial photography dated 1948. It is unlikely that the single fire bomb recorded would have caused significant enough damage for the structure to be cleared. It must be noted that the consulted record sets are not comprehensive, and it is possible that additional, unrecorded, bomb strikes occurred in the vicinity to which this damage could be attributed. This is evidenced by the ruins visible approximately 30m north of the Site in post-WWII OS mapping and aerial photography; this significant damage cannot be attributed to any recorded bomb strikes.
- As briefly discussed above, analysis of post-WWII aerial photography indicates that the Site experienced significant bomb damage during WWII; this is somewhat corroborative of the bomb damage mapping, although the extent of the damage differs. The single large pre-WWII industrial structure is no longer present, with two smaller structures and an area of open ground present in its place. The structure in the centre of the Site in particular looks newly built in the photography; this change in the Site's composition indicates that the original pre-WWII structure sustained substantial bomb damage during WWII. The structure in the east of the Site does not show any immediately obvious signs of bomb damage, however, is likely also newly built. It is not possible to confirm the exact date that the composition of the Site changed; however, given the recorded bomb strike on Site, it is thought likely this occurred as a response to bomb damage during WWII. Further damage is visible 30m north of the Site, where multiple structures have been severely damaged, leaving ruins in their place.

- Following this damage, the ground conditions are likely to have been largely unconducive to the visual detection of UXBs, and entry holes could easily be obscured in rubble / debris. Furthermore, the area would likely have been cordoned off / abandoned for a period, potentially until the end of the war. Had access levels decreased in the manner anticipated, this marked drop in access could have created a situation wherein a subsequent UXB strike could easily go unnoticed and unrecorded. Such an occurrence is also possible within the areas of open, undeveloped land on / adjacent to the Site, which does not appear to have had an obvious use and appear poorly maintained in consulted aerial photography. These areas are anticipated to have experienced infrequent levels of access, and a UXB strike could easily occur unobserved, its entry hole obscured by vegetation and infilling over time.
- A UXB strike to these open areas, or the ruins in the centre of the Site, could feasibly have come to rest beneath any undamaged structures on Site due to the J-curve effect, whereby an item of ordnance may travel laterally beneath the surface from its point of entry. Had the structure or roadway in the east of the Site survived the war externally structurally intact, a UXB could also have come to rest underneath these owing to the lateral offset (J-curve) effect. In addition, via this method, a UXB strike to the canal immediately north of the Site could also come to rest within the Site boundary, and would leave little evidence of its occurrence as the entry hole could be beneath the water line.
- In summary, given the evidence of bomb damage on Site visible in WWII-era aerial photography and OS mapping, alongside the subsequent anticipated infrequent levels of access, and ground cover unconducive to the visual detection of UXBs, the risk of encountering UXBs on Site has been assessed as **Moderate**.

British / Allied UXO:

- Numerous (>30) permanent HAA batteries were active within range of the Site during WWII. Luftwaffe activity was relatively frequent and intense over the wider area and therefore these guns would have expended a significant quantity of ammunition. Consequently, it is possible that an unexploded AA shell struck the Site and became obscured in any rubble / debris.
- No evidence of historic military activity within the Site boundary has been found and it is highly unlikely that any has occurred historically. Consequently, the risk from associated UXO is **Low**.

Likelihood of UXO Remaining and UXO Encounter:

- The risk associated with any deep buried German UXBs will likely not have been mitigated at all across the Site. The risk associated with any very shallow or shallow buried HAA shells will have been mitigated with the clearing of pre-WWII structures and the subsequent construction/clearance of the post-war industrial structures.
- Please note, the risk of a UXO encounter can be considered mitigated in the exact locations and down to the exact depths of any post-WWII intrusive works.

RECOMMENDED RISK MITIGATION MEASURES: The measures detailed below are recommended to mitigate the risk to ALARP level.

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings	Prior to all intrusive works commencing.
Intrusive Magnetometer Probe Survey	Of all pile positions.
EOD Engineer - On Site Supervision	Watching brief of all open excavations and magnetometer survey of all borehole locations.

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FIGURES

FIGURE 1: Site Location Maps

FIGURE 2: Recent Aerial Photograph

FIGURE 3: Current Site Plan

FIGURE 4: Historical OS Mapping

FIGURE 5: Historical Aerial Photography

FIGURE 6: Manchester Bomb plot & Damage Map: 1940 - 1941

APPENDICES

APPENDIX 1: Recent UXO Incidents and Historical Analysis

APPENDIX 2: Data Sheets - German WWII Air-Delivered Munitions

APPENDIX 3: Data Sheet - British WWII Anti-Aircraft Munitions

APPENDIX 4: Glossary

APPENDIX 5: Bibliography

QUALITY POLICY

Brimstone Site Investigation Ltd, known as Brimstone, is committed to the delivery of unexploded ordnance (UXO) risk mitigation services, including safe removal and disposal of explosive ordnance, in the UK and overseas. Since our incorporation in 2016 it has been our goal to provide unsurpassed and unbiased UXO risk mitigation services. Brimstone is a client-centric organisation, with the aim to provide the client the services they need, to the agreed requirement, in accordance with national and international standards or standard operating procedures.

We are committed to providing a safe, cost-effective, and quality service, underpinned by our core values:

- **Integrity:** We are unwavering in our commitment to providing pristine, unbiased counsel and superior services. Our ethical compass guides every interaction, ensuring we maintain the highest standards of conduct in all our endeavours.
- **Professionalism:** We embody professionalism at every level, conducting our business with unparalleled excellence. Our commitment to quality guarantees top-tier service and a seamless experience for every client.
- **Knowledge:** We are devoted to perpetual growth, consistently expanding our expertise to stay at the forefront of industry innovation and strategy. Our thirst for knowledge ensures we are equipped to lead and succeed in an evolving marketplace.
- **Innovation:** We champion innovation, continuously advancing our services and processes. Our pursuit of inventive strategies and pioneering solutions ensures we not only meet but exceed the evolving needs of our clients and the industry.

We are committed to the applicable requirements of the ISO 9001:2015 standards. We set and review quality monitoring objectives using the plan, do, check, act cycle to measure the performance of our quality management system. Brimstone wholly endorses the ethos of 'continual improvement efforts' and allocates resources to meet this requirement.

This policy applies to the whole of the Brimstone services and involves all personnel including the managing director. All personnel are responsible for helping manage quality, seeking improvement through constant review, and by encouraging supplier and subcontractor involvement. We are committed to achieving customer satisfaction using quality procedures, which will be operated to meet or exceed the applicable requirements of ISO 9001.

[redacted]

Aaron Florence
Founder and Managing Director
Brimstone Site Investigation Ltd.

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1 INTRODUCTION

1.1 Background

E3P Consulting (the Client) has commissioned Brimstone to carry out a Stage 2 Detailed Unexploded Ordnance Risk Assessment (DRA) of the proposed redevelopment works at the Crabtree Lane, Manchester site (the Site).

1.2 Legislation

There are no regulations that specifically govern the UXO risk mitigation industry in the UK. However, there are two pieces of legislation that require consideration. It is industry best practice (and common sense) to frame your site in the context of UXO, and to put in place measures to protect people from risks. In 2009, CIRIA published Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681. This publication, though not legally binding, provides the gold-standard framework to which UXO and construction companies operate.

1.2.1 Construction Design and Management Regulations (CDM) 2015

The regulations identify the client, the CDM coordinator, the designer, and the principal contractor as responsible parties. Under the regulations, responsible parties are held accountable for the way a construction project is managed and for the health and safety of workers. Responsible parties must:

- Provide an appropriate assessment of potential UXO risks, or ensure an assessment is completed by another party.
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks.
- Ensure the preparation of an emergency response plan.

1.2.2 The Health and Safety at Work Act 1974

The Health and Safety at Work Act 1974 had a transformative impact on health and safety, saving thousands of lives since its enactment. Employers must consider their employees, workers not in their employment, and members of the public. The act places a duty on every employer 'as far as is reasonably practicable' to protect workers from risks. It also says that information must be provided about aspects of health and safety that affect their role.

1.3 Commercial Contractor and the Authorities

1.3.1 Commercial Contractors

If your site has been given a moderate or high-risk rating, then control measures will be recommended. The measures will be specific to the scope of works on site, usually in relation to the depth and extent of excavations, piling and similar activities. There are a range of different methods at Brimstone's disposal, including:

- Non-intrusive surveying (including drone surveying)
- Intrusive surveying
- Search and clear
- Watching brief
- Support to geotechnical investigations
- Target investigation
- Site-specific training packages
- Site safety briefings

Our UXO Engineers can assess suspicious items on site when they are found. This will avoid unnecessary site

evacuations. If our engineer(s) decide the item is UXO, they will coordinate with the authorities, manage disruptions, and advise on control measures, such as evacuations and a cordon.

1.3.2 UK Authorities

If Brimstone is not on site and a suspicious item is found, the local police must be immediately called on the non-emergency number. Police will visit the site. They will then inform the Joint Services Explosive Ordnance Disposal (JSEOD) office, which will coordinate the callout of an army or navy response team.

A precautionary cordon will initially be put into effect, with possible evacuation of homes and businesses, road and rail closures. The cordon may be extended following the advice from JSEOD's response team.

To manage their resources, JSEOD triages incidents. A consideration of the type, size and location of the UXO is made. If an incident is not given a high priority rating, a team may not be available for up to two days following the initial report.

The use of JSEOD is under the Military Aid to Civil Authorities (MACA) framework, therefore the budget and personnel is limited, and there are no statutory obligations made of the MOD. Often the MOD will recommend involvement of a commercial UXO contractor to manage the ongoing risk – this is especially true of former airfields and training areas where contact with land service ammunition can be frequent.

1.4 UXO Risk in the UK

Fortunately, to the best of our knowledge, there has not been a single post-war incident in the UK where a construction worker has been killed or injured because of an item of UXO exploding. There have been cases in mainland Europe where UXO had been struck and then exploded, killing workers. In 2019, a WWII general purpose bomb spontaneously detonated in a field north of Frankfurt, Germany.

However, the incident in Frankfurt is not comparable to the UK, due to the way different countries manufactured ordnance. Bombs made in different countries have different associated hazards. British WWII bombs, for example, have a fuzing system which uses chemicals which makes them very unsafe. Please see **APPENDIX 1** for recent examples of UK UXO incidents.

Between 2013 and 2016 JSEOD responded to 7,500 callouts. These callouts range from falsely identified objects, inert objects, small items of UXO and large WWII German unexploded bombs (UXBs). Each year the construction industry inadvertently unearths UXO; often this goes unreported. UXO contamination comes from three main sources:

- **Enemy action:** during WWI and WWII the air forces of Germany, and to a lesser extent Italy, bombed targets throughout the UK. The German navy bombarded several coastal targets in eastern England during WWI and then in WWII German long-range artillery on the French coast bombarded parts of Kent.
- **Allied military activity:** during WWI and WWII several Allied nations used the UK as a staging area for military action in the European Theatre; predominantly the US and Canada.
- **UK military activity:** domestic British Army, Royal Air Force (RAF) and Royal Navy (RN) training activities during peacetime and conflict as well as anti-aircraft gun and rocket batteries during WWI and WWII.

1.5 UXO Detonations

A detonation is a violent chemical reaction which creates a huge volume of gas. This reaction appears to happen instantaneously – the velocity of the shockwave moving is up to 9,000m per second. This chemical reaction is started using a small amount of very sensitive explosives called primary explosives. These types of explosives are highly sensitive to shock, friction, heat, and spark. As the explosive charge undergoes high order decomposition (detonation), the brisance, or shattering effect, causes the casing to splinter, projecting razor-sharp shrapnel across long distances.

The blast wave effect and the shrapnel effect can cause significant damage. Calculating safety distances is a

complex process. As a rule of thumb, in open ground, a 250kg explosive charge (as would be found inside a typical 500kg bomb) would require an omnidirectional safety distance of at least 1.6km.

Bombs work by amplifying the explosive charge from the sensitive primary explosive through to the main charge or fill of the item. This process is called an explosive train, if any link in that chain is broken, the item will fail to function as intended. This can be due to mechanical, electrical, or manufacturing tolerances or faults. Amongst other reasons, detonation of UXO could occur under the following circumstances:

- **UXO body impact:** A substantial impact onto the main body of a UXO; borehole rigs, piling rigs, jack hammers and mechanical excavator buckets.
- **Fuse impact:** Environmental conditions during decades of burial can result in the primary explosives located in the fuse pocket to crystallise and become shock sensitive. It would then take a relatively small impact or friction impact to cause the fuse to function and detonate the UXO.
- **Re-starting a timer:** A small proportion of German WWII bombs used clockwork fuses. In 2002, an Army EOD Engineer reported that the clockwork fuse in a UXB re-started. Decades of burial causes substantial corrosion in WWII German UXBs and therefore an incident such as this is extremely rare.

2 ASSESSMENT METHODOLOGY

2.1 Introduction

This assessment has been produced in accordance with the relevant CIRIA guidelines; *Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681* (published in 2009). CIRIA C681 is a publication which originated from round table best practice discussions from industry leaders.

2.2 SPRC Risk Model

The Source, Pathway, Receptor, Consequence (SPRC) risk model can be applied to buried UXO as follows:

- **Sources:** UK and Allied UXO sources include military firing ranges, bases, storage depots, munitions factories, anti-aircraft batteries, amongst others. There are many wartime causes of UXO contamination. The source for enemy contamination is overwhelmingly from WWII German air raids.
- **Pathways:** the pathway describes how the UXO reaches receptors. Usually, UXO is buried and therefore pathways can be any activity which involve breaking ground. Examples include ground investigation works, site enabling works and excavations.
- **Receptors:** receptors are the people, assets and infrastructure that can be adversely affected by UXO exposure. This includes site personnel, plant, equipment, buildings, the general public, and the environment.
- **Consequence:** the consequences of an inadvertent UXO detonation are catastrophic. They include injury and loss or life, as well as damage to property. Fortunately, the likelihood of UXO detonating is low, even when it is uncovered during works. However, another consequence to consider is delays to works, which itself can be a risk.

2.3 Assessment Structure

In accordance with CIRIA C681 this assessment addresses the following considerations in the appropriate order:

- The likelihood that the site was contaminated with UXO.
- The type of UXO that could have contaminated the site, and their associated hazards.
- The likelihood that UXO remains on the site.
- Theoretical bomb penetration depths.

- The likelihood that UXO will be uncovered during the proposed works.
- Risk rating and risk mapping (as appropriate).
- Risk mitigation recommendations.

2.4 Information Sources

To complete this risk assessment, Brimstone has gathered information from a wide range of sources. Brimstone's research team has completed detailed historical research, including access of original archived records. The following is a general list of information sources that are consulted during the research process:

- The National Archives,
- Local archive centres,
- Ministry of Defence,
- The Council for British Archaeology,
- Groundsure mapping services,
- Historical aerial photography (Historic England, Britain from Above, NCAP),
- Google open-source mapping,
- The British Geological Society,
- Open sources; published book, articles, web resources,
- Site-specific information supplied by the Client,
- Brimstone's library and historical database, and
- Brimstone's former armed forces employees.

2.5 ALARP Principle

The ALARP (as low as reasonably practicable) principle corresponds to the actions that should be taken to reduce risks. The term 'ALARP' is in the Health and Safety at Work Act 1974, which says that risks must be controlled in a reasonable way.

Infinite time, effort and money could be spent trying to eliminate risk entirely. HSE uses the example that spending £1m to prevent five employees bruising their knees is disproportionate, whereas spending the same amount to prevent an explosion which could kill 150 people is proportionate.

Using this principle, Brimstone aims to reduce client costs by recommending strategies that are proportionate to the assessed risks, if any elevated risk is found at all.

2.6 Risk Tolerances

The Brimstone risk assessment process divides UXO risk into two tolerances:

- **Tolerable:** Low Risk and Low-Moderate Risk ratings are tolerable. Where the risk cannot be completely discounted, it may be a useful strategy to opt for a low-cost measure, such as a UXO safety briefing from a qualified UXO engineer.
- **Intolerable:** Moderate, Moderate-High, and High-Risk ratings are intolerable. Proactive risk mitigation measures should be put in place. Various strategies are at Brimstone's disposal to meet your project-specific needs.

2.7 Reliance and Limitations

This report has been prepared using published information and information provided by the Client. Brimstone is not liable for any information which has become available following the publication of this report. No third-party liability or duty of care is extended. Any third-party using information contained in this assessment do so at their own risk.

3 THE PROJECT

3.1 The Site

The Site (centred on the National Grid Ref: SJ 88784 98091) is located in Clayton, within Manchester, approximately 1.1km north-west of Gorton station. The Site is bound to the north by the Manchester and Ashton under Lyme canal, to the east and south by mature vegetation, and to the west by Crabtree Lane.

The Site comprises an area of open, brownfield land. It appears to be utilised for the storage of raw building materials, and multiple shipping containers are visible in the north.

FIGURE 1: Site Location Maps **FIGURE 2:** Recent Aerial Photograph

3.2 The Proposed Works

Development works on site will be residential. Whilst the Site layout isn't confirmed at the time of writing, it is likely to comprise low-rise residential properties in the centre and south, with three high-rise apartment blocks broadly spaced along the northern boundary with the canal. At the time of writing, Brimstone was not aware of any planned SI works taking place on Site.

FIGURE 3: Existing Site Plan

4 SITE HISTORY

4.1 Site Introduction

Site-specific history can be assessed by reviewing historical mapping, historical aerial photography and by carrying out additional Site-specific research where appropriate. Below are descriptions of a selection of records relevant to the Site:

4.2 Mapping

Period	Map Date	Map Scale	Review
Pre-WWI	1893	1:2,500	The majority of the Site comprises open, undeveloped ground. A small cluster of structures is present in the east of the Site, labelled as an Iron Foundry. An unnamed roadway intersects the north of the Site, connecting the iron foundry and Crabtree Lane. The Manchester & Ashton under Lyne Canal is present directly north of the Site, with open undeveloped ground to the east and south, and Crabtree Lane to the west.
	1908	1:2,500	The iron works has been extended and now encompasses the majority of the Site. Additional small structures have bene developed in the south of the Site.

WWI	**1922**	**1:2,500**	No significant changes appear to have taken place on Site. The iron works directly west of the Site has been extended, and is now labelled 'Crabtree Forge'.
Pre-WWII	**1932-1933**	**1:2,500**	**FIGURE 4.1:** The works on Site is now labelled 'Acre Works (Packing Materials). The structures in the south of the Site have also been cleared. Edge Lane Chemical Works is now present adjacent to the Site across the canal to the north.
Post-WWII	**1949-1950**	**1:1,250**	**FIGURE 4.2:** The large structure on Site is no longer present, and two smaller structures are in its place. Two ruins are labelled approximately 30m north of the Site on the adjacent side of the canal.
	1994	**1:1,250**	The two structures on Site are now labelled as 'Works', and the small structures in the south of the Site have been cleared.
	2003	**1:1,250**	All of the structures on Site have not been cleared, leaving an area of open, brownfield land.

4.3 Photography/Aerial Photography

Period	Photo Date	Review
Post-WWII	**16th May 1948**	**FIGURE 5:** This vertical image displays the Site approximately three years after the end of WWII. The structures on Site do not match the layout displayed in pre-WWII OS mapping; however, the westerly structure does not show any immediately obvious evidence of bomb damage such as light-coloured roofing, indicating repairs. Such evidence is visible to the structure in the centre of the Site, however. An area of open ground is present in the east of the Site; this is possibly an area of structural clearance given the change in Site composition between this image and pre-WWII OS mapping. Ruins are visible approximately 30m north of the Site, while the Crabtree Foundry directly west of the Site appears to have survived the war largely externally structurally intact, although a small area of clearance appears to be visible in the south of the foundry. An area of ground disturbance is visible approximately 90m south of the Site. Whilst it is not possible to confirm their exact cause, these are potentially indicative of bomb damage.

4.4 Additional Site-Specific History

Some sites will have been occupied by landmarks or significant buildings historically and in such cases specific written histories including significant wartime details are occasionally available in the public domain. No such information was available.

5 UXO RISK - GERMAN BOMBING

5.1 WWII Bombing History of the Site

5.1.1 Greater Manchester

Greater Manchester was home to a number of vital wartime industries during WWII, many of which were located in Trafford Park. Infrastructure of strategic importance was also present in the form of Manchester Docks and the Manchester Ship Canal.

Between 29th July 1940 and 30th July 1942, Greater Manchester experienced 41 air raids, most of which were small in scale, often executed by a solitary bomber. At least nine relatively insignificant raids were carried out during the autumn of 1940, with the first medium scale raid affecting a wide area, occurring on 28th August, then on 1st October, a medium to heavy raid was executed.

The Luftwaffe mounted consecutive major attacks on the nights of 22nd-24th December 1940 (the 'Christmas Blitz'). These left large areas of Manchester, Salford and Stretford devastated. NB: a major attack was a Luftwaffe designation for a raid delivering >100 tonnes of HE (in addition to incendiaries) to a target area.

In total, these two attacks involved 441 German bombers dropping 272 tonnes of HE on the first night and 195 tonnes of HE on the second night. Seven conflagrations and 600 smaller fires were reported, the result of tens of thousands of small incendiary bombs (IBs). The Christmas Blitz caused the total destruction of >4,000 houses as well as serious damage to a further 12,000. 805 HE bombs were reported across Manchester, Salford, Stretford and Manchester Docks, including 134 UXBs.

During 1941, two additional major* raids was launched on 9th January and 1st June. Although each involved half as many aircraft as 22nd December 1940 raid, they still delivered a further 208 tonnes of HE bombs and numerous IBs onto the city and surrounding area. Three medium scale raids were also mounted in 1941, during the spring.

*The fourth and final major raid actually only delivered 97 tonnes of HE. However, it is close enough to 100 tonnes to be considered 'major.

5.1.2 Site Specific

Luftwaffe target photography indicates that Gorton Locomotive Works, approximately 690m south of the Site, and North Street Works, approximately 600m west of the Site, were identified as primary targets. The industrial structures on Site, and immediately west, may have provided targets of opportunity.

5.1.3 Bombing Decoy Sites

In mid-1940 bombing decoys were introduced. The decoys used either:

- A system of lighting to simulate an urban area or a military airfield's runway,
- Deliberately started fires to simulate a previously bombed target,
- Dummy buildings and vehicles to simulate a military facility.

792 static decoy sites were built at 593 locations in Britain. They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. No decoys were operational within a significant radius of the Site during WWII. The closest was approximately 4.7km to the south-east.

5.2 WWII Bombing Records

5.2.1 Introduction

The bomb census recorded the location and type of bomb strikes to help with intelligence gathering and planning. It was compiled using information recorded by ARP wardens. These records were gathered by the Ministry of Home Security to calculate bombing density within administrative areas.

The bomb census was unreliable in the early stages of the war, though by 1941 procedures had been standardised. The quality of the census records also depended on where in the UK the records were produced. Some records are held at the National Archives and some are held at local borough archives.

Relevant records held at the National Archives and the Greater Manchester County Record Office were obtained for this risk assessment.

5.2.2 Bombing Density Statistics

The table below records the Ministry of Home Security's bombing density calculation for the County Borough of Manchester. It gives a breakdown of the types of large German bombs reported and is understood to not include UXBs.

Admin Area	Manchester
Area Acreage	27,255
High Explosive Bombs (all types/weights)	712
High Explosive Parachute Mines	18
Flam (Oil) Bombs	7
40kg Phosphorus Incendiary Bombs (IBs)	0
40kg 'Fire Pot' IBs	0
V1 Flying Bomb	1
V2 Long Range Rocket	0
Total (excluding V-Weapons and 1kg / 2kg IBs)	737
Bombs Per 1,000 Acres	**27.0**

1kg / 2kg incendiary bombs (IBs) and 2kg anti-personnel (AP) bombs were often too numerous to record accurately and therefore are not included in the above figures.

5.2.3 Manchester Bomb Plot & Damage Map: 1940 - 1941

Brimstone has reviewed an original bomb plot and damage map for the wider study area. This map was produced by Manchester City Council's Architect's Department (Building Surveyor's Division) during the war and was updated throughout the conflict to reflect all raids on the city. No original legend / key accompanies this map; however, a contemporary description does confirm some symbols. No symbol for UXBs was identified and any IB strike symbol with a number written within it represents the number of individual IBs falling at that location. Three categories of damage are illustrated on this map: solid red, hatched red and red outline. These are likely to represent 'total destruction or severe damage' (solid red), 'moderate damage' (hatched red) and 'minor blast damage' (red outline) respectively.

A small section of the map covering the study area is presented at **FIGURE 6** and described below.

- One 'fire bomb' is recorded within the Site boundary.
- A further four 'fire bombs' are recorded within an approximate 500m radius of the Site.
- The large industrial structure on site has been hatched red, indicating that it experienced moderate damage. This appears to have been cleared at some point during the war as indicated by post-WWII aerial photography (see **FIGURE 5**).

5.2.4 Manchester Civilian Fatalities Map

A contemporary digital map of Greater Manchester recording the locations of every Christmas Blitz bombing incident that resulted in at least one fatality, was reviewed. This map (published by the Manchester Evening News) was compiled using data from the Commonwealth War Graves Commission; however, it only covers the two heaviest air raids on the city. Although a potentially significant source of bombing incident locations, many bombs did not cause a fatality and therefore this map should not be viewed as comprehensive.

No fatalities were recorded on or adjacent to the Site. The nearest plotted incident was plotted at '31 John Street, Droylsden, one fatality' (approximately 880m east of the Site).

5.2.5 Abandoned Bomb Register

Due to the overstretched bomb disposal units during WWII, many bombs were intentionally left undisturbed. UXBs were triaged based on where they were and how big they were. If they didn't pose a significant risk, they were 'abandoned'. The locations of these bombs were recorded on the abandoned bomb register.

The abandoned bomb register is a public record document held at the Parliamentary Archives of the House of Commons, from which Brimstone has obtained a copy. The register should not be relied on for completeness or accuracy. No abandoned bombs were recorded within a close vicinity of the Site. The nearest was within Salford Docks, approximately 7.8km west of the Site.

5.2.6 Secondary Source / Anecdotal Evidence

A search of online resources, as well as a review of local history publications was carried out with the intention of locating any eyewitness accounts of local bombing incidents. However, no such evidence was found.

5.3 Likelihood of UXB Contamination

Where detailed bombing records exist, it is possible to predict whether any UXBs could be found on a site. This likelihood is discussed in the following table:

Density of Bombing	
Number of Air Raids in the Vicinity:	A comparison of the bombing incident records confirms that at least one air raid affected the study area. Note, this number is almost certainly higher, as available records are not comprehensive, and evidence of additional raids in the area is visible. The damage sustained by the Site is not consistent with the one fire bomb recorded on Site, and no recorded bomb strikes can be attributed to the ruins approximately 30m north of the Site.
Intensity of these Air Raids:	The majority of bombs dropped in the local area appear to have been part of small-scale raids, although it is also feasible that the Site area was affected by the large-scale raids targeting Manchester.
Bomb Strike Positions	
Closest Bomb Strikes	HE bombs: None recorded within the wider Site area (approx. 500m radius). 1kg / 2kg IBs: On Site.

Alignment of recorded Bomb Strikes:	It has not been possible to identify any potential bomb sticks (individual aircraft bombloads) in the local area due to the limitations of available record sets. For most small IB spreads (covering a wide area) it is impossible to correctly identify the aircraft's flightpath and thus bomb-stick alignment. Furthermore, such bombs were significantly affected by the wind, further hampering analysis.
Bomb Failure Rate	
Evidence to suggest that the generally accepted failure rate of 10% differs in the vicinity of the Site:	Records of exploded and unexploded HE bombs dropped on Manchester, Salford and Stretford during the Christmas Blitz give a failure rate of 16.6% (Smith. P, J, C, 2003). This is higher than the national average of 10%.
UXBs recorded in close proximity to the Site:	None recorded within a significant distance of the Site.

5.4 Likelihood of Subsequent UXB Detection

A range of circumstances determine whether a UXB strike location would have been identified, during and after the war. This is discussed in the following table.

Historic Access
A UXB falling on a site which was frequently accessed would have had a better chance of being found. ARP Wardens actively searched for UXBs in heavily bombed residential areas. The importance of a site or nearby buildings and infrastructure was also a factor. Many industrial facilities had fire watchers tasked with extinguishing incendiary bombs and reporting UXBs.
As the majority of air raids in the immediate vicinity appear to have occurred during the hours of darkness, there is a greater probability that any UXB strike to the Site could have occurred unobserved as residents / employees were inside. However, at the outbreak of WWII, the developed areas of the Site will have experienced a frequent level of access, as the works was in use and any UXB strike would not have been overlooked by returning employees. However, following the substantial bomb damage to the structure in the centre of the Site and structural clearance in the east, it would likely have been abandoned / cordoned off for a significant period. Note, a newly constructed structure is visible on Site in 1948 aerial imagery; it is not known if this construction occurred during the latter years of WWII or immediately post-war. It is therefore feasible that a UXB strike to the ruins of the damaged structure went unnoticed. Furthermore, the small areas of open/undeveloped ground on Site do not appear to have had an obvious use, and so would likely not have been frequently accessed during any periods where the structure on Site was vacant. The same can be said for the accessway in the west of the Site.

Bomb Damage
As the bombing campaign continued, damaged areas became vulnerable to unreported UXBs. Bomb site wreckage or soil disturbance at a bomb crater could obscure evidence of a subsequent UXB strike.
The main structure on Site appears to have sustained significant bomb damage during WWII. A newly built structure is visible in its place in 1948 aerial photography, alongside an area of open ground in the west, in an area which is developed in pre-WWII OS mapping. Subsequently, structural clearance appears to have occurred in this location. Multiple ruins are visible approximately 30m north of the Site, these are also recorded as ruins in post-WWII OS mapping. This is indicative of substantial bomb damage.

Ground Cover Type
A UXB which falls on open field could easily go unnoticed, whereas a UXB dropped on a hard-surfaced car park would have been easily observed.
Any UXB strike to the undamaged structures on Site would have caused incontrovertible evidence of its incidence as it passed the structures and into the ground beneath. The same can be said for neighbouring structures to the south-west, where (assuming no cratering) a HE UXB entry hole would have been persistent and easily recognisable. However, a subsequent UXB strike to the ruins of the damaged structure on Site may have gone unnoticed, its entry hole obscured by rubble / debris. Any such UXB strike could have come to rest away from its entry hole via the J-curve effect. It is conceivable that the small undeveloped areas on / adjacent to the Site may have been overgrown/unmaintained at some point during WWII. A small UXB entry hole could easily have been obscured within such ground cover. Over time, changing environmental conditions could have caused this hole to infill, erasing any evidence of a UXB. NB: the diameter of the smallest German HE bomb (50kg, which was also the most commonly deployed over Britain) was 20cm, creating a small easily obscured entry hole.

5.5 Bombing During WWI

During WWI, an estimated 9,000 German bombs were dropped on London, Eastern England and South-Eastern England during some 51 Zeppelin airship raids and 52 fixed-wing aircraft raids. London suffered the worst of the bombing with an estimated 250 tonnes of HE and incendiary bombs recorded across the Capital, over half of which fell on the City of London district.

The WWI bombing campaign waged by Germany was on a far smaller scale than the WWII campaign, in terms of the number of raids, the weight of ordnance dropped during each attack and the size of the bombs used. When coupled with the fact that most WWI-bombed locations have since been redeveloped, German WWI UXB finds are extremely rare. Furthermore, most air raids took place during daylight hours and as it was the first time Britain had experienced strategic aerial bombardment, the raids often attracted public interest and even spectators, increasing the chances of any UXBs being reported.

A collection of written reports describing each air raid in the region was reviewed.[1] No evidence that Manchester was targeted by enemy bombing during WWI was uncovered.

6 WWII GERMAN BOMBS

6.1 Bombs Dropped on the UK

Nazi Germany used different types of ordnance against the UK for different effects. Some types were designed to cause fires, others for their destructive blast effect and other for their penetration capability. Each type of ordnance was fitted with at least one fuze. For some bombs multiple fuzes were used. Many different types of fuzes were available for use – each with its own set of associated hazards.

Data sheets on those bombs most likely to be encountered today are included at **APPENDIX 2**.

- **HE bombs – moderate NEQ (net explosive quantity):** the most common types of HE bombs dropped were the SC (general purpose - GP) and SD (semi-armour piercing - SAP) series of bombs. The NEQ is between 30-50%. SAP bombs are engineered to attack light fortifications, whereas GP bombs are used in a mixed destructive blast and anti-personnel fragmentation role. 70% of bombs dropped on the UK were the 50kg type.
- **HE bombs – high NEQ:** blast bombs and parachute mines have bodies made of thin steel, allowing for larger HE charges. These were designed to detonate above ground, maximising the blast effect.

[1] https://www.iancastlezeppelin.co.uk/

Parachute mines were weapons slowed by parachutes and designed to detonate without penetrating the ground. Although, in some marshland areas, partially buried parachute mines have been observed. Consequently, it is highly unlikely that any unexploded blast bombs remain buried in the UK today.

- **HE bombs – low NEQ:** The PC series were armour piercing bombs used against heavy fortifications and reinforced bunkers. They were not commonly used over the UK.
- **Small incendiary bombs:** The 1kg and 2kg incendiaries were the most dropped bomb. Up to 620 x 1kg incendiaries could be packed into the largest container unit, which opened at a pre-determined height scattering its payload over a wide area. These small bombs could fully penetrate soft ground due to their small diameter. Variants of the 1kg and 2kg incendiary bombs contained a small HE charge designed for an anti-personnel role, and to increase its incendiary effect.
- **Large incendiary bombs - Thick skinned:** The C50 has a thick body and contained a mixture of incendiary liquids and white phosphorus. Another version of the C50 had a white phosphorus fill. The C50 'firepot' contained thermite incendiary containers (aka firepots) and a small HE charge.
- **Large incendiary bombs - Thin skinned:** The Flam 250 and Flam 500 models had thin steel bodies designed to break up on impact, spreading their oil-incendiary mixture, which was ignited by a small HE charge. Consequently, it is highly unlikely that any unexploded Flam bombs remain buried in the UK today. Their unreliability meant withdrawal from frontline use by January 1941.
- **Submunitions:** The SD2 'butterfly' bomb was a 2kg submunition dropped on several British cities and towns. It contained a 225gram HE charge. SD2s had no ground penetration ability so the vast majority were recovered at the time. However, SD2s are still found across Britain today.
- **V1 flying bombs and V2 rockets:** In the final year of WWII Germany began using pilotless weapons against England. Both V Weapons had 1,000kg HE warheads. Due to their light-body construction, they had no penetration ability, and any impact left a noticeable debris field. As such, there is negligible risk from unexploded V Weapons today.

6.2 Bomb Failures

Records from September 1940 to July 1941 show that an average of 84 UXBs were dropped on civilian targets each day. Around 8% of these were time delay bombs – designed to strike the ground and start a predetermined countdown which could last days.

There is a generally accepted 10% failure rate for WWII German HE bombs. This is estimated from records gathered by bomb disposal units. These statistics do not account for UXBs that went by unnoticed.

Failures can happen for different reasons, including:

- Equipment or human error in arming the bombs before release,
- Failure of a mechanism within the fuze (out of tolerance),
- Jettisoning payloads if the bomber was under attack or crashing, or
- Partially functioned bombs (e.g. cracks in the cast TNT).

6.3 Bomb Ground Penetration

6.3.1 Introduction

Using data gathered during WWII by the Ministry of Home Security, estimations can be made about how deep a bomb is likely to penetrate the ground. Over one thousand incidents were reported by the bomb disposal units to support this research. Further tests were carried out, dropping bombs of different sizes into chalk and measuring the depths they reached. This research is held at the National Archives. The estimates are:

Bomb weight (kg)	Ground Type (m)									
	Sand		Gravel		Chalk		Clay		Sandstone	
	Average	Max.	Average	Max.	Average	Max.	Average	Max.	Average	Max.
50	2.8	7.8	2.8	7.8	3.5	7.7	4.0	9.1	2.7	6.0
250	4.8	13.7	4.8	13.7	6.0	13.1	6.8	15.8	4.6	10.4
500	6.0	17.3	6.0	17.3	7.6	16.4	8.7	19.8	5.8	13.1
1,000	7.6	21.9	7.6	21.9	9.6	20.7	10.9	24.9	7.3	16.5

Different layers of geology affect penetration depths. For example, 1m of made ground, then 1m of gravel before reaching clay – as is many areas of London – is not easily calculated from the data above.

When calculating how deep a bomb could have reached, we must make three assumptions:

- **Impact velocity:** German bombing raids were carried out at altitudes in excess of 5,000m. The velocity of impact is roughly 313ms^{-1} (not accounting for resistance). It is the same velocity regardless of mass.
- **Impact angle:** strike angles of 10 to 15 degrees to the vertical. It must be assumed that the bomb was stable at the moment of ground penetration.
- **Bomb design:** Some larger German bombs were occasionally fitted with 'kopfrings' - a metal ring, triangular in cross section, fitted around the nose of the bomb to help prevent penetration. It must be assumed that no 'kopfrings' were fitted.

6.3.2 The J-Curve Effect

During WWII, BDUs reported that most buried UXBs were found horizontal or upturned. This observation confirmed the 'J-curve effect'. As an HE bomb penetrates the ground, slightly offset from the vertical, its passage underground creates a 'J' shape.

This is relevant because the J-curve effect results in a horizontal offset between the buried UXB and its point of entry. This is distance is estimated to be one third of the theoretical penetration depth. A low altitude attack, meaning a low impact angle, could produce an even greater offset, of up to 15m.

6.3.3 Site Specific Geology

BGS Mapping	**Superficial Deposits:** n/a	**Bedrock Deposits:** Manchester Marls Formation (Mudstone)
SI Data	No recent SI data was provided by the Client. However, local BGS borehole logs were available. The closest BGS SI through the same mapped geology as the Site is located approximately 160m south of the Site (BGS ID: 13468717). This SI (October 1984) encountered the following ground conditions: - 2.50m of made ground (bricks, clay and stones) - 1.40m of made ground (loose ash and shale) - 0.40m of very soft brown clay - 1.40m of very loose brown sand with pieces of brick and clay - 2.80m of loose to compact brown sand with small coal pieces - 0.50m of brown sand with thin bands of clay - 0.80m of soft laminated clay - 0.60m of loose brown layered silt with thin bands of soft clay - 2.70m of very stiff brown clay	

6.3.4 Site Specific Maximum Bomb Penetration Depth

During WWII, the Luftwaffe dropped many different types of HE bomb. The SC (general purpose) series was by far the most numerous and of this series, the SC 500 model (weighing 500kg) was the largest of the most commonly deployed and therefore this will be used as the benchmark weapon for the Site-specific bomb penetration depth calculations.

In order to calculate the most likely maximum depth to which a bomb would penetrate, Brimstone has taken the average of the average and maximum figures for the predominant Site-specific geology (clay and sand) in the table above. This gives a likely maximum bomb penetration depth of 12.95m below WWII ground level for a 500kg bomb.

Note, the Ministry of Home Security data indicates that the maximum bomb penetration depth could be down to 19.8m for a 500kg bomb, or 24.9m for a 1,000kg bomb; however, in line with the ALARP principle, it is not considered to be a likely scenario that a bomb would penetrate so deeply. Furthermore, while evidence indicates that a 1800kg HE bomb could penetrate to over 30m, these types of bombs were not dropped frequently. For example, War Office statistics confirm that between October 1940 and May 1941 the majority of HE UXBs (>90%) were either 50kg or 250kg, with the 500kg bombs making up most of the remaining 10%.

However, any UXB striking the structures on Site will have first passed through multiple stories. This will have caused the bomb to lose kinetic energy prior to ground penetration. This factor indicates that sections of the Site will have had a maximum bomb penetration depth significantly shallower than 14.25m. However, this makes calculating an accurate depth impossible.

7 UXO RISK - BRITISH/ALLIED ACTIVITY

7.1 Introduction

The table below lists potential sources of UXO (excluding enemy action). Those which are potentially relevant to the Site are discussed in the subsequent section(s).

Potential UXO Source	Potentially Significant
Army or RAF training areas / ranges	×
Military bases and other installations	×
Munitions and explosives factories	×
Military storage depots	×
Defensive fortifications	×
Wartime site requisitions	×
WWII defensive mining (landmines)	×
WWII Home Guard activity	×
Wartime anti-aircraft fire	✓

7.2 Potential Sources of UXO

7.2.1 Introduction

Research has not located any evidence of significant British or Allied army, RAF or Royal Navy activity specifically on Site and none is likely to have occurred historically. The only likely potential source of British UXO contamination is therefore WWII AA artillery fire.

7.2.2 WWII Anti-Aircraft Fire

Anti-Aircraft (AA) Command was a British Army command established in 1939 to defend the UK during the anticipated German bombing campaign. It controlled the Territorial Army AA artillery and searchlight units. From 1940 to 1945 BDUs dealt with 7,000 unexploded AA shells in Britain. There were three main types of AA battery used for home defence (see below). Data sheets on these AA defences are included at **APPENDIX 3**.

- **Heavy Anti-Aircraft (HAA):** large-calibre guns (3.7" and 4.5") for engaging high-altitude bomber formations. Hundreds of permanent batteries were constructed in and around major cities and military bases during the 1930s. Some 2,000 of these guns were available during the Blitz. Each gun could fire between 10 and 20 rounds per minute and consequently HAA batteries could expend large quantities of shells during each engagement.

  British time fuses were poorly manufactured during WWII, and this led to high failure rate for HAA shells, up to 30%. Unexploded HAA shells had the potential to land up to 27km from their battery, although more typically landed within a 15km radius.

- **Light Anti-Aircraft (LAA):** smaller calibre guns for engaging dive bombers and low altitude intruders. As such, they were mostly used to defend specific industrial and military targets which were subject to precision bomber attack. LAA guns were either .303" calibre machine guns or 20mm and 40mm calibre cannon. The latter were fitted with simply impact fuses and small incendiary or HE bursting charges.

  The 40mm Bofors gun could fire 120 x HE shells / minute to a ceiling of 1,800m. Each shell was designed to self-destruct if it didn't strike an aircraft, however, inevitably some failed and fell back to earth.

- **Z (Rocket) Batteries**: a Z-Battery comprised a grid formation of 64 rocket projectors which fired 2" and later 3" Unrotated Projectile (UP) rockets to a maximum altitude of 5,800m; a ground range of some 9,000m. They were deployed in cities all around the UK from 1941 and proved to be an effective addition to the existing AA guns.

  The rockets measured 0.9m (2") and 1.8m (3") in length with four stabilising fins at the base and were fitted with 3.5kg or 8.2kg HE warheads. The larger warhead had an effective airborne blast radius of up to 20m. Some variants deployed a form of aerial mine described as a "small yellow bomb" which was designed to detach from the rocket at height and descend on a parachute with the objective of becoming snagged on target aircraft and then detonating.

Unlike bombs which were designed to strike the ground, AA projectiles and rockets were designed to function in the air. Due to their shape, and centre of gravity they would often not strike the ground nose first. This coupled with the lower mass of AA UXO resulted in shallower ground penetration depths, compared to UXBs. Although, in very soft conditions, unexploded AA projectiles have been found deeper than 1.5m bgl.

Numerous (>30) permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was relatively frequent and intense over the wider area and therefore these guns would have expended a sizeable quantity of ammunition. Consequently, there is an elevated likelihood of unexploded AA shells striking the Site and penetrating to a shallow depth, potentially becoming obscured in any rubble / debris.

8 UXO RISK MITIGATING CIRCUMSTANCES

8.1 Introduction

Works on a UXO contaminated site could result in the partial or complete removal of UXO risk. Construction or earthworks may have uncovered any UXO contamination, which would then have been reported and removed by the authorities. A site may have been subject to an explosive ordnance clearance (EOC) task conducted by the armed forces. EOC tasks involve surveying, subsequent target investigation and removal of UXO. Although the effectiveness of historic EOC tasks will have often been unsatisfactory.

8.2 Explosive Ordnance Clearance Tasks

The division of EOD tasks has been complex throughout British military history. It used to be the case that anything under the water level would be dealt with by navy units, and anything on land would be dealt with by army units. In recent years, RAF EOD capability has been discontinued, and now only the Royal Navy and the British Army have EOD units. In the army, the Royal Logistics Corps and Royal Engineer EOD units have been amalgamated to form 29 EOD & Search Group. Often taskings are assigned to either the naval or army elements based on where in the country the threat is and the nature of the threat.

Brimstone has access to a database of historic EOC tasks. This database is only complete up until the early 2000s and therefore does not include recent EOC tasks. No such database for the RAF and Royal Navy EOD units is easily accessible. A search of this database has not resulted in any Army EOC tasks in the vicinity of the Site.

UXO encounters on civilian land are often reported in the media and therefore a web search of local media outlets was also carried out. No recent incidents within close proximity to the Site were identified.

8.3 Ground Works

It is not thought likely that any of the post conflict ground works occurring on Site have disturbed ground to a deep (>2m bgl) depth. The construction of the post-WWII industrial structures on Site likely disturbed ground to a shallow (1-2m bgl) depths; the same can be said for the subsequent clearance of these structures, and the grubbing out of any foundations. General maintenance of the Site, and the potential re-laying of any hardstanding, may have disturbed ground to a very shallow (<1m) depth.

8.4 Deductions

The risk associated with any deep buried German UXBs will likely not have been mitigated at all across the Site. The risk associated with any very shallow or shallow buried HAA shells will have been mitigated with the clearing of pre-WWII structures and the subsequent construction/clearance of the post-war structures.

Please note, the risk of a UXO encounter can be considered mitigated in the exact locations and down to the exact depths of any post-WWII intrusive works.

9 CONCLUSION

9.1 Accuracy of Historical Records

Occasionally, the accuracy of some historical records can prove to be poor when compared with other sources of information. One significant consequence of this can be the possibility of unrecorded German bomb strikes in the study area. No comprehensive record set for the County Borough of Manchester exists, and as such there are vast disparities between the damage recorded in available record sets and what is visible in WWII-era aerial photography. For example, there are no bomb strikes recorded to account for the ruins visible approximately 30m north of the Site. These ruins are also not recorded as having sustained any damage in the bomb plot and damage mapping, although these sources are known to not be comprehensive.

9.2 The Risk of UXO Contamination on Site

9.2.1 Key Findings – German UXO Risk

- Greater Manchester was the 11th most heavily bombed British conurbation during WWII. Like today, the Site occupied an area on the periphery of the city centre during the Blitz. Analysis of Luftwaffe target mapping indicates that Gorton Locomotive Works, approximately 690m south of the Site, and North Street Works, approximately 600m west of the Site, were identified as primary targets. However, the industrial structures present on Site and in the immediate surrounds may have been identified as targets of opportunity.
- Indeed, one 'fire bomb' is recorded within the Site boundary on a bomb plot and damage map for Manchester, with a further four within an approximate 500m radius. The large industrial structure on Site is hatched in red in this source, indicating that it experienced moderate bomb damage during WWII. At some point during WWII, however, this building appears to have been cleared, as evidenced by post-WWII aerial photography dated 1948. It is unlikely that the single fire bomb recorded would have caused significant enough damage for the structure to be cleared. It must be noted that the consulted record sets are not comprehensive, and it is possible that additional, unrecorded, bomb strikes occurred in the vicinity to which this damage could be attributed. This is evidenced by the ruins visible approximately 30m north of the Site in post-WWII OS mapping and aerial photography; this significant damage cannot be attributed to any recorded bomb strikes.
- As briefly discussed above, analysis of post-WWII aerial photography indicates that the Site experienced significant bomb damage during WWII; this is somewhat corroborative of the bomb damage mapping, although the extent of the damage differs. The single large pre-WWII industrial structure is no longer present, with two smaller structures and an area of open ground present in its place. The structure in the centre of the Site in particular looks newly built in the photography; this change in the Site's composition indicates that the original pre-WWII structure sustained substantial bomb damage during WWII. The structure in the east of the Site does not show any immediately obvious signs of bomb damage, however, is likely also newly built. It is not possible to confirm the exact date that the composition of the Site changed; however, given the recorded bomb strike on Site, it is thought likely this occurred as a response to bomb damage during WWII. Further damage is visible 30m north of the Site, where multiple structures have been severely damaged, leaving ruins in their place.
- Following this damage, the ground conditions are likely to have been largely unconducive to the visual detection of UXBs, and entry holes could easily be obscured in rubble / debris. Furthermore, the area would likely have been cordoned off / abandoned for a period, potentially until the end of the war. Had access levels decreased in the manner anticipated, this marked drop in access could have created a situation wherein a subsequent UXB strike could easily go unnoticed and unrecorded. Such an occurrence is also possible within the areas of open, undeveloped land on / adjacent to the Site, which does not appear to have had an obvious use and appear poorly maintained in consulted aerial photography. These areas are anticipated to have experienced infrequent levels of access, and a UXB strike could easily occur unobserved, its entry hole obscured by vegetation and infilling over time.
- A UXB strike to these open areas, or the ruins in the centre of the Site, could feasibly have come to rest beneath any undamaged structures on Site due to the J-curve effect, whereby an item of ordnance may travel laterally beneath the surface from its point of entry. Had the structure or roadway in the east of the Site survived the war externally structurally intact, a UXB could also have come to rest underneath these owing to the lateral offset (J-curve) effect. In addition, via this method, a UXB strike to the canal immediately north of the Site could also come to rest within the Site boundary, and would leave little evidence of its occurrence as the entry hole could be beneath the water line.

- In summary, given the evidence of bomb damage on Site visible in WWII-era aerial photography and OS mapping, alongside the subsequent anticipated infrequent levels of access, and ground cover unconducive to the visual detection of UXBs, the risk of encountering UXBs on Site has been assessed as **Moderate**.

9.2.2 Key Findings - British UXO Risk

- Numerous (>30) permanent HAA batteries were active within range of the Site during WWII. Luftwaffe activity was relatively frequent and intense over the wider area and therefore these guns would have expended a significant quantity of ammunition. Consequently, it is possible that an unexploded AA shell struck the Site and became obscured in any rubble / debris.
- No evidence of historic military activity within the Site boundary has been found and it is highly unlikely that any has occurred historically. Consequently, the risk from associated UXO is **Low.**

9.3 Site-Specific UXO Hazards

Different types of UXO pose differing types of hazard, depending on their structural design, Net Explosive Quantity (NEQ), fill type and likely contamination depth. The table below lists the main types of UXO most often encountered on urban UK sites and their relative hazard levels.

UXO Type	NEQ (NEQ Range)	Likely Burial Depth	Hazard Posed
WWII German General Purpose HE Bombs	25kg - 220kg (most commonly deployed bomb weights)	Likely deep burial (>2m)	**HIGH RISK**
WWII British Heavy Anti-Aircraft Shells (HAA Shells)	1.1kg - 1.7kg	Shallow burial (1-2m)	**MODERATE-HIGH RISK**
WWII British Land Service Ammunition (LSA)	<2kg	Shallow burial (1-2m)	
WWII German 2kg Incendiary / HE Bombs (IBs)	680g incendiary hazard + ~500g explosive hazard	Shallow burial (1-2m)	
WWII German 1kg IBs	680g (incendiary, not explosive hazard)	Shallow burial (1-2m)	**MODERATE RISK**
WWII British Light Anti-Aircraft Shells (LAA Shells)	4g - 70g	Very shallow burial (<1m)	**LOW-MODERATE RISK**
Small Arms Ammunition (SAA)	<1g	Very shallow burial (<1m)	**LOW RISK**
Inert/Practice Item	0g	Very shallow burial (<1m)	

9.4 The Likelihood of UXO Encounter

9.4.1 Introduction

This report assesses the risk of UXO in relation to the proposed works, not simply the risk that UXO remains buried on Site. The likelihood of UXO encounter during intrusive ground works will vary depending on the type of UXO and the type of construction methods employed during the project. With increased soil disturbance i.e. more excavations, the likelihood of encountering UXO increases.

Within an area of elevated UXO contamination likelihood, the sub-surface volume of potential UXO contamination will comprise the natural soil / geology in between WWII ground level and the maximum bomb penetration depth. Therefore, any intrusions into this layer will be at risk of UXO encounter.

Any post-WWII fill material deposited on a site is unlikely to be contaminated with UXO and therefore the risk of encountering UXO on such a site could vary with depth.

In the wake of the initial nine-month Blitz, many cities and towns were left with vast quantities of bomb site rubble that required removal and relocation. This material was put to use for in a variety of ways, for example >750,000 tons of London's rubble was used to build runways for new RAF and USAAF airfields and much of Liverpool's rubble was used to create and maintain sea / flood defences throughout Merseyside.

It is quite possible that unexploded British AA projectiles and German 1kg incendiaries were overlooked during removal, resulting in UXO contaminated fill material ending up on otherwise low UXO risk sites, possibly many miles from any high bombing density areas.

9.4.2 German UXBs

Although most German UXBs came to rest several metres below WWII ground level, these weapons can be found at any level between just below WWII ground level and the maximum bomb penetration depth. There are a number of reasons why these heavy bombs might be found at surprisingly shallow depths.

- **Tip and run:** When enemy aircraft had to take evasive action to escape RAF fighter intercepts or AA defences, they often dropped their bomb loads from a reduced height, potentially resulting in extreme J-curve effect.
- **Deflection:** the shape of German bomb nose sections meant they were susceptible to deflection when striking surface or shallow sub-surface obstacles, occasionally resulting in shallow burial or even UXBs skidding across hardstanding.
- **Aircraft Crash Site:** if an aircraft was unable to dump its bomb load before impacting the ground, due to mechanical fault, any externally fitted bombs could have become buried on impact.

German 1kg / 2kg incendiaries were cylindrical and approximately 50mm in diameter. They had tail sections, and so landed nose first. Within soft ground this could result in full penetration of the bomb below the surface. Such UXBs are usually found close to the surface.

9.4.3 British / Allied UXO

The nature of British/Allied military activity involving LSA and SAA and the smaller size of these munitions (in relation to German HE bombs) indicates that any resulting UXO contamination on a site will be limited to shallow depths, usually within 1.5m of the surface, notwithstanding added material to raise the ground level.

Domestic military LSA and SAA contamination will either be the result of expending blinds (dud ammunition) which bury into the ground on impact or munitions purposefully buried, for a number of reasons. Either way, these types of UXO are all found at shallow depth.

9.4.4 Deductions

An elevated likelihood of UXO contamination (German) and likelihood of that UXO remaining up to the present day has been identified across the entire Site. Therefore, all the proposed works are considered to be exposed to a UXO encounter.

10 OVERALL RISK RATING

Ratings for the likelihood of UXO contaminating the Site, remaining within the Site up to the present day and being encountered during the proposed works, inform the overall risk rating. Please refer to the UXO hazard table presented in ***Section 9.3*** for a breakdown of the most common hazards and their associated risk. The colour of each respective type of hazard indicates the associated risk, as defined within the aforementioned table. The UXO risk to the proposed works has been assessed as **Moderate.**

Risk Table					
Risk Zone	**UXO Type (Hazard)**	**Likelihood of UXO Contamination**	**Likelihood of UXO Remaining**	**Likelihood of UXO Encounter**	**Overall Risk Rating**
Moderate Risk	**WWII German GP HE Bombs**	Moderate	Moderate-High	Moderate	**MODERATE**
	HAA Shells	Moderate	Moderate	Moderate	
	LSA	Low	n/a		**LOW**
	German 2kg IBs	Low	n/a		
	German 1kg IBs	Low	n/a		
	LAA Shells	Low	n/a		
	SAA	Low	n/a		

11 RISK MITIGATION RECOMMENDATIONS

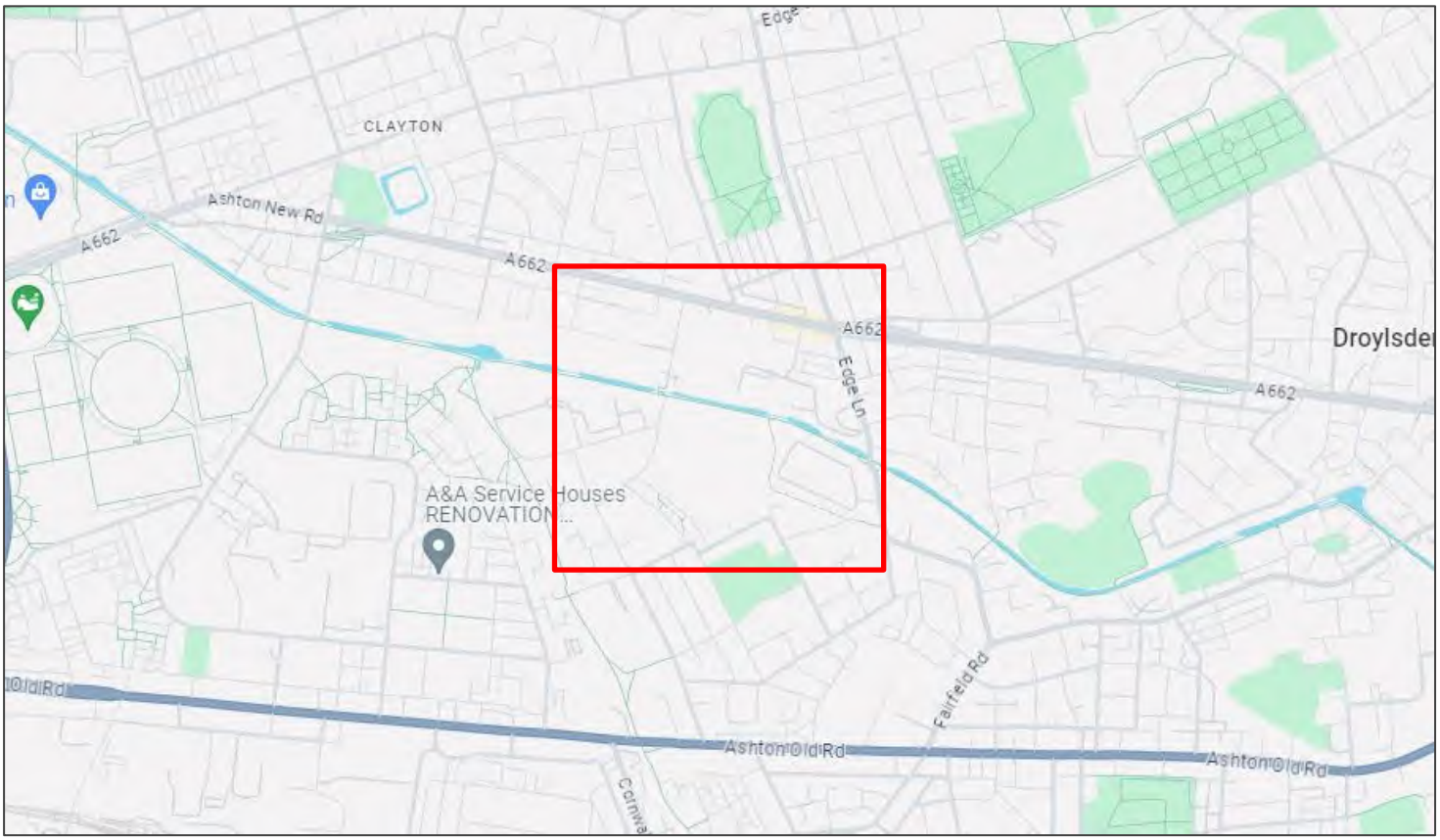
Brimstone has identified an elevated UXO risk to the proposed works. The measures detailed below are recommended to mitigate the risk to ALARP level.

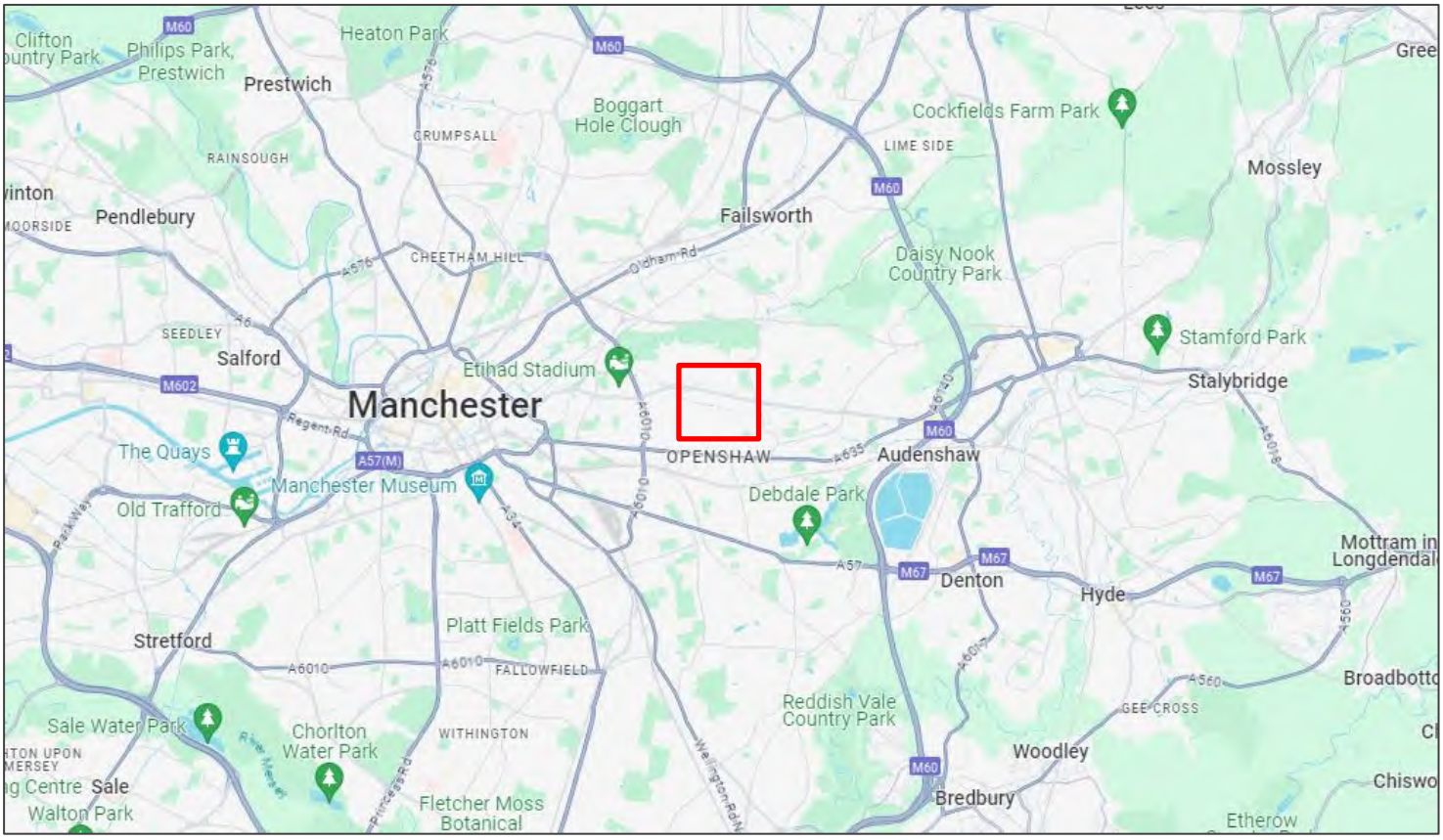
Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings: To all personnel conducting intrusive works on Site. An essential part of the Health & Safety Plan for a site. Conforms to the requirements of CDM2015.	Prior to all intrusive works commencing.
EOD Engineer - On Site Supervision: Watching brief for open excavations below WWII ground level. Portable magnetometer instruments for clearing ground ahead of borehole positions and shallow excavations (where / when appropriate). Positive identification of suspicious (non UXO) objects. Liaison during confirmed UXO incidents. Provision of additional UXO Safety Awareness Briefings.	Watching brief of all open excavations and magnetometer survey of borehole locations.
Intrusive Magnetometer Probe Survey: A range of intrusive magnetometer methodologies can be deployed to survey the ground (down to the maximum bomb penetration depth) prior to deep intrusive works; pile foundations. The appropriate technique is governed by a number of factors, the most important being the site-specific ground conditions.	Of all/any pile positions.

FIGURES: 1 - 6

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N	Title:	Site Location Maps	FIGURE: 1





Project:	**Crabtree Lane, Manchester**
Client:	**E3P Consulting**
Report Ref:	**DRA-24-1690**
General Site Location:	Info Source: Google (open-source)

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N	Title:	Recent Aerial Photograph	FIGURE: 2



Project:	Crabtree Lane, Manchester
Client:	E3P Consulting
Report Ref:	DRA-24-1690
Approx. Site Boundary:	Info Source: Google (open-source)

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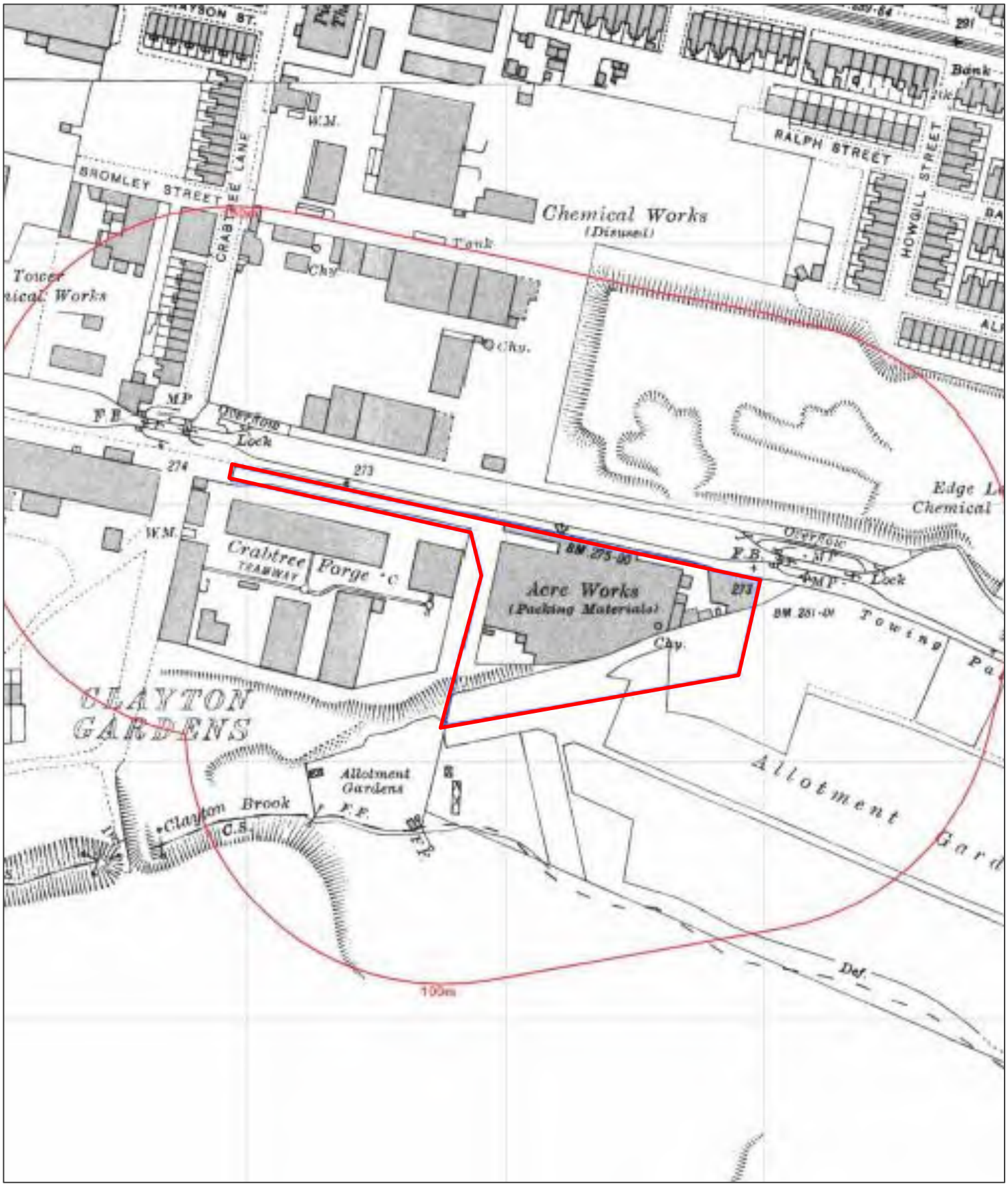
N	Title:	Existing Site Plan	FIGURE: 3



Project:	Crabtree Lane, Manchester
Client:	E3P Consulting
Report Ref:	DRA-24-1690
Site Boundary:	Info Source: E3P Consulting

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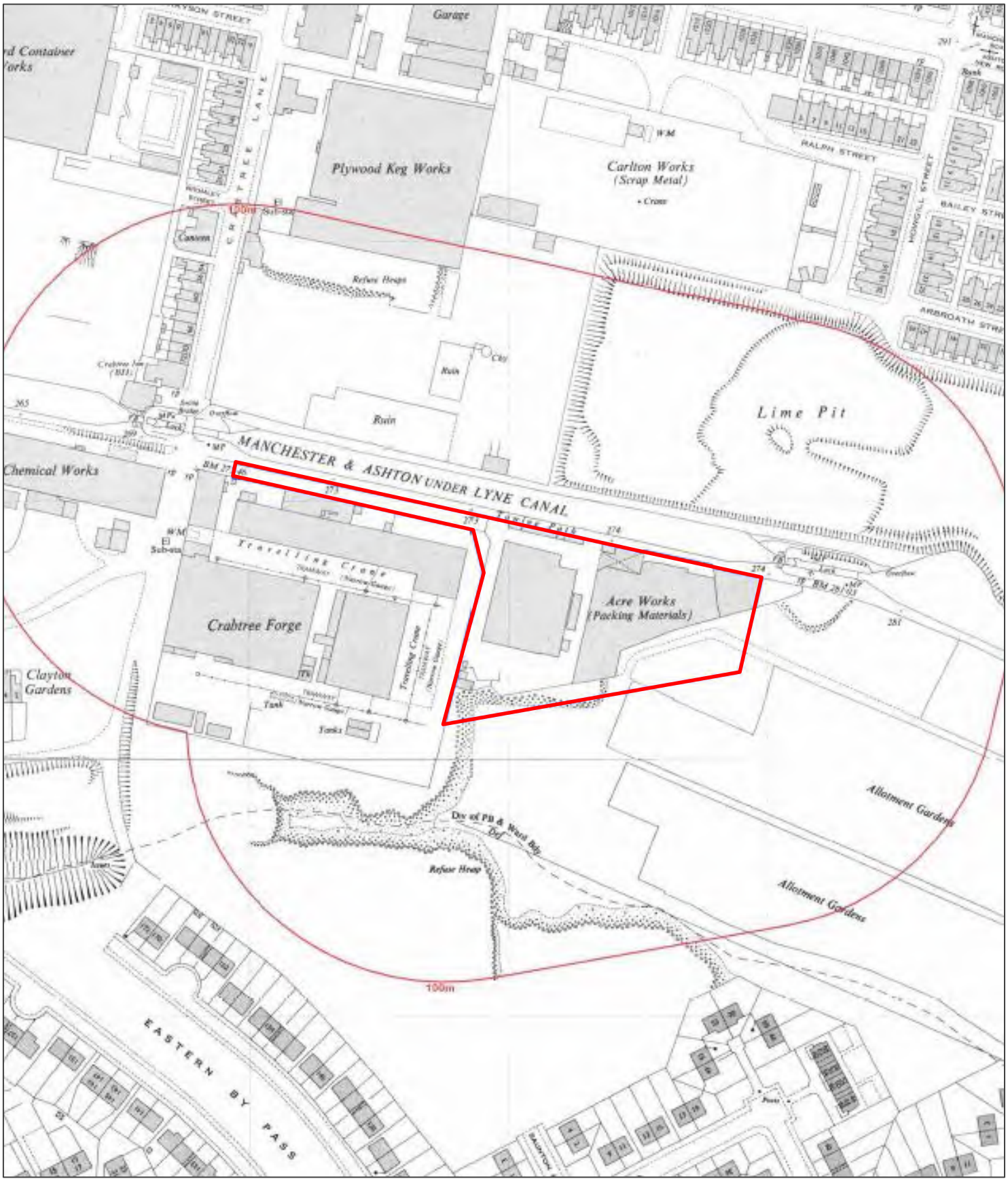
N	Title:	Historical OS Mapping – 1932 - 1933	FIGURE: 4.1



Project:	Crabtree Lane, Manchester
Client:	E3P Consulting
Report Ref:	DRA-24-1690
Approx. Site Boundary:	Info Source: E3P Consulting

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N	Title:	Historical OS Mapping - 1949	FIGURE: 4.2



Project:	Crabtree Lane, Manchester
Client:	E3P Consulting
Report Ref:	DRA-24-1690
Approx. Site Boundary:	Info Source: E3P Consulting

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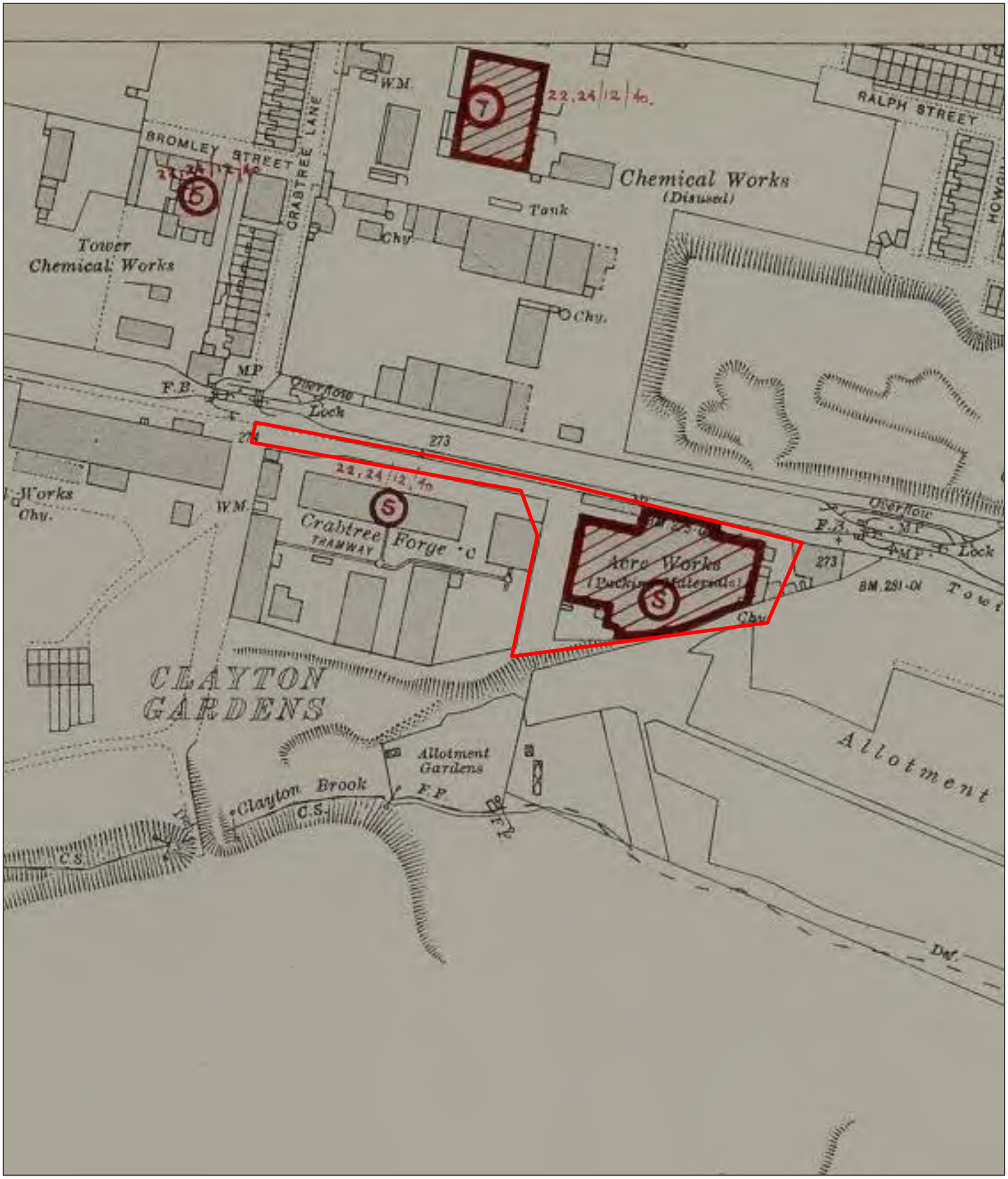
Title:	Historical Aerial Photography – 16th May 1948	FIGURE: 5



Project:	Crabtree Lane, Manchester
Client:	E3P Consulting
Report Ref:	DRA-24-1690
Approx. Site Boundary:	Info Source: Historic England

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N	**Title:** Manchester Bomb Plot & Damage Map: 1940 - 1941	**FIGURE: 6**



Project:	**Crabtree Lane, Manchester**
Client:	**E3P Consulting**
Report Ref:	**DRA-24-1690**
Approx. Site Boundary:	Info Source: **Greater Manchester County Record Office**

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APPENDICES: 1 - 5

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Recent German UXB Finds in the UK + Historical Analysis

- ***23rd May 2019*** - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Kingston upon Thames, London. *Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest approximately 3 to 4m bgl.*
- ***15th May 2017 -*** An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Aston, Birmingham. *Historical Analysis: The UXB landed in a small back garden belonging to a terraced house, part of a row. It J-Curved under a neighbouring garden and came to rest at just 1.4m bgl. NB: These houses had not sustained bomb damage.*
- ***2nd March 2017 -*** A 250kg HE bomb was found during deep excavations at a building site in Brondesbury Park, London. *Historical Analysis: UXB landed in a large residential back garden. A single storey building was built on top of the UXB post-WWII.*
- ***19th January 2017 -*** An SD50 (semi-armour piercing 50kg HE bomb) was dredged from the Thames during barge dredging works near Westminster Bridge, London.
- ***12th May 2016 -*** A 500kg HE bomb was found buried just 1m below the playground of the former Royal High Junior School in Bath. *Historical Analysis: The UXB landed in a plot of neglected, unmaintained vegetation in between the school gym and main school building.*
- ***23rd September 2015 -*** A 1,000kg HE bomb was encountered by a mechanical excavator on a building site in Paradise Street, Coventry. *Historical Analysis: the UXB landed in a large residential back garden occupied by dense vegetation. A two storey building was built on top of the UXB post-WWII.*
- ***10th August 2015 -*** A 250kg HE bomb was found immediately beneath a basement floor during refurbishment works in Temple Street, Bethnal Green (London). *Historical Analysis: The UXB struck a house that had been damaged beyond repair during a previous air raid. The existing house was then built on top of UXB post-WWII.*
- ***21st May 2015 -*** An SC50 (general purpose 50kg HE bomb) was found during deep excavations at a construction site in Wembley, London. *Historical Analysis: UXB landed in a large residential back garden.*
- ***23rd March 2015 -*** A 250kg HE bomb was found during deep excavations at a building site in Grange Walk, Bermondsey (London). *Historical Analysis: inconclusive - reported UXB position is likely inaccurate.*

NB: Domestic UXO finds in the UK are too numerous to list. Between 2006 and 2009, over 15,000 items of British / Allied UXO (excluding small arms ammunition) were found on UK construction sites (CIRIA).

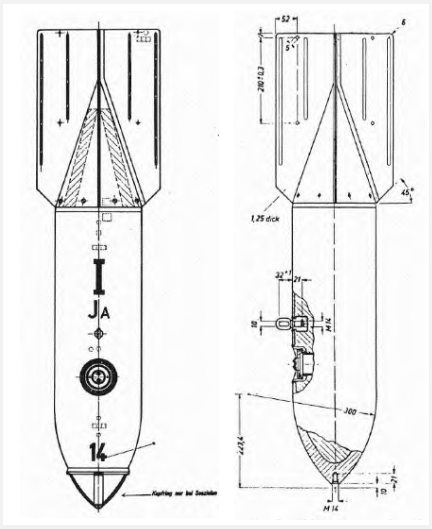
Initiation of WWII Allied Bombs

- ***6th January 2014 -*** Mechanical excavator stuck a WWII bomb in Euskirchen (Germany) causing it to explode, killing the operator and injuring 13 more, two critically. The explosion was so large it damaged buildings 400m away.
- ***1st March 2013 -*** During piling at a construction site in Ludwigshafen (Germany) a small buried WWII bomb exploded, injuring one worker.
- ***2nd June 2010 -*** A British 500kg bomb detonated whilst being defused, killing three EOD engineers in Goettingen, Germany. The bomb was found as builders dug the foundations for a new sports hall. Several houses had their fronts blown off by the blast.
- ***19th September 2008 -*** Seventeen people were injured and buildings were damaged when an excavator apparently drove over and set off a 250kg American bomb at a construction site in Hattingen, Germany.
- ***23rd October 2006 -*** A construction worker breaking up tarmac at the side of a highway near the south-western German town of Aschaffenburg was killed when his machine struck and detonated a WWII bomb. In addition, the blast injured several motorists who were driving past.
- ***2006 -*** A piling rig and dump truck were destroyed when a piling rig struck an Allied bomb on a construction site in Austria.
- ***2003 -*** In the Austrian city of Salzburg, two people were killed while attempting to defuse a 250kg Allied bomb.
- ***1994 -*** At a central Berlin construction site a piling rig struck a large WWII Allied bomb. 3 were killed and 14 more were injured. Dozens of cars in a 250m radius were wrecked, the top 10 floors of neighbouring office building collapsed and human remains were found 100m away.
- ***1990*** - In Wetzlar (Germany) two EOD engineers were blown up as they removed the detonator of an allied WWII UXB.

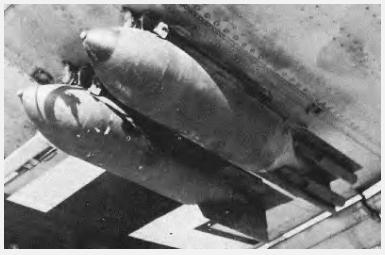
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SC 50

Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	25kg (55lb)
Filling:	TNT, Amatol or Trialen
Charge/Weight Ratio:	46%
Fuse Type:	Electrical impact fuse or mechanical delayed action fuse
Body Dimensions:	1,100mm length x 200mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Additional fittings: Kopfring nose for limited penetration and Stabbo nose for dive-bombing.

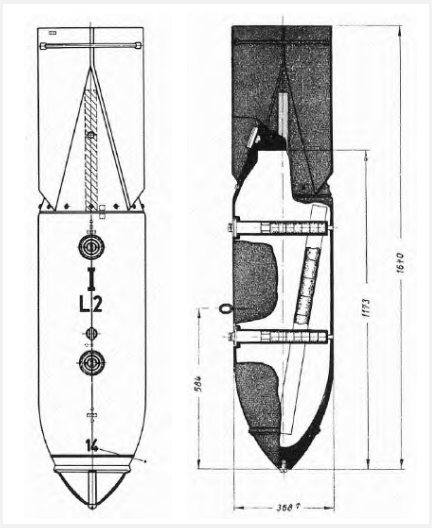






SC 250

Bomb Weight:	245-256kg (540-564lb)
Explosive Weight:	125-130kg (276-287lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	1 or 2 electrical impact fuse(s) or mechanical delayed action fuse(s)
Body Dimensions:	1,173mm length x 368mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Kopfring nose for limited penetration. Stabbo nose for dive-bombing.

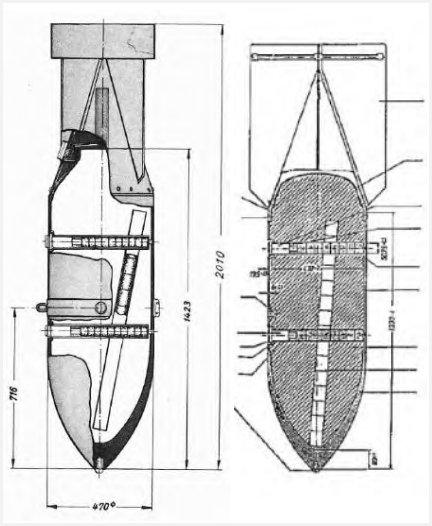






SC 500

Bomb Weight:	480-520kg (1,058-1,146lb)
Explosive Weight:	220kg (485lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	2 electrical impact fuses or mechanical delayed action fuses
Body Dimensions:	1,423mm length x 470mm diameter
Appearance:	Bomb body and tail painted grey/green or buff with a yellow stripe on the tail unit. Steel construction.
Variants:	3 x variants. Kopfring nose for limited penetration.



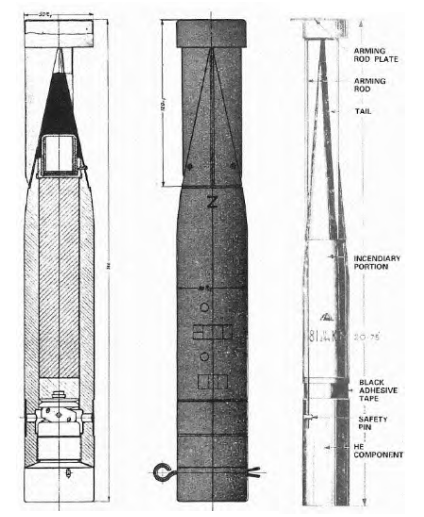




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B-1E Sub-Munition

Bomb Weight:	1-1.3kg (2.2-2.87lb)
Incendiary Weight:	680g (1.4lb)
Filling:	Thermite
Fuse Type:	Simple impact fuse
Body Dimensions:	247mm length x 50mm diameter
Appearance:	Grey body and dark green painted tail unit. Magnesium alloy case.
Operation:	Small percussion charge ignites Thermite (>1,000°C burn).
Variants:	Most common variant: B 2EZ (2kg) included a small HE charge
Remarks:	Drop containers varied in size. The smallest cluster bomb held 36 x B-1Es and the largest 620 x B-1Es.

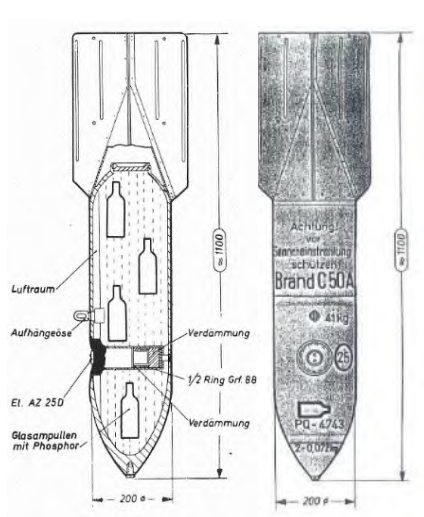






Brand C50

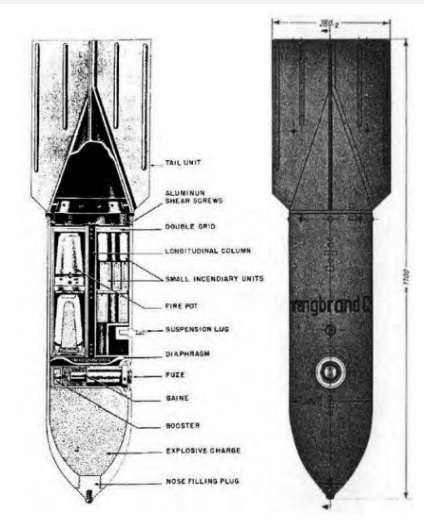
Bomb Weight:	41kg (90.4lb)
Incendiary Weight:	13kg (30lb)
Filling:	Main fill (86% Benzine, 10% Rubber) plus 4% Phosphorus in glass bottles
Fuse Type:	1 x electrical impact fuse
Bomb Dimensions:	762mm length x 203mm diameter
Appearance:	bomb body and tail painted grey or green with the rear of the bomb painted red and a red band around the centre of the body.
Variants:	C 50 B: 77% White Phos fill C 250 A: 87.7% Petroleum, 11.7% Polystyrene, 0.5% White Phos (185kg version)

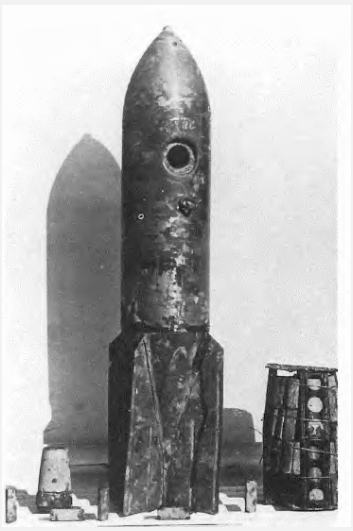




Spreng-Brand C50 - *Fire Pot*

Bomb Weight:	34kg (75lb)
Explosive Weight:	9kg (20lb)
Filling:	TNT burster charge, 6 x Thermite containers (fire pots) and 67 x small triangular incendiary elements.
Fuse Type:	1 x electrical impact fuses or aerial burst fuse
Bomb Dimensions:	711mm length x 203mm diameter
Appearance:	Bomb body and tail painted grey/green or pale blue with red base plug and red or green incendiary markings. Steel construction.
Operation:	A charge blows off the base plate, firing a plume of incendiary mixture 100 yds. Approx 1 second later the HE charge detonates.



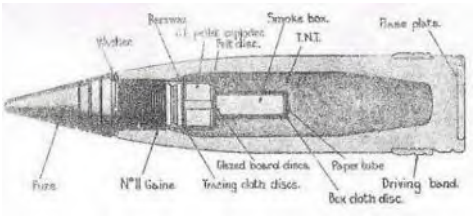


Project:	**Crabtree Lane, Manchester**
Client:	**E3P Consulting**
Report Ref:	**DRA-24-1690**
Info Source:	*W, Ramsey.1988 / various news sources*

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HAA Battery - 3.7" QF Shell

Shell Weight:	12.7kg
Shell Dimensions:	94mm x 438mm
Fill Weight:	1.1kg
Fill Type:	TNT
Fuse Type:	Mechanical Time Delay fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	10 - 20 rpm
Ceiling:	9,000 - 18,000m
Variants:	HE or shrapnel shells. Note, the 4.5" gun was also used in an HAA role throughout the UK.

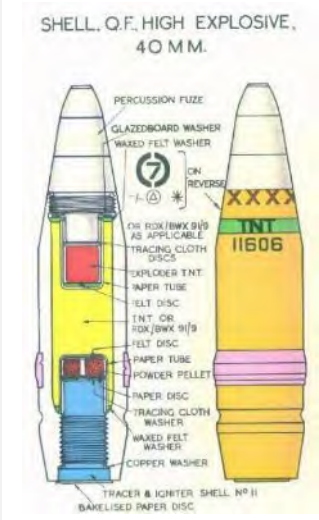






LAA Battery - 40mm Bofors Shell

Shell Weight:	0.84kg
Shell Dimensions:	40mm x 180mm
Fill Weight:	70g
Fill Type:	TNT
Fuse Type:	Impact fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	120 rpm
Ceiling:	7,000m
Variants:	HE or AP shells. Both with rear tracer compartment



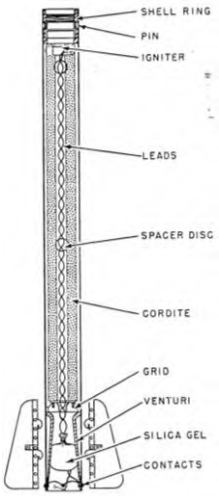






Z Battery - 3" U.P Rocket

Rocket Weight:	24.5kg
Warhead Weight:	1.94kg
Filling:	TNT warhead. Black Powder solid fuel rocket motor.
Fuse Type:	Mechanical Time Delay fuse
Rocket Dimensions:	1,930mm x 76mm
Ceiling:	6,770m
Operation:	Fired from single, tandem and (later) 36 x rail launchers (Z Batteries). Limited use throughout the UK.





Project:	**Crabtree Lane, Manchester**
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AA	*Anti-Aircraft (defences)*
AFS	*Auxiliary Fire Service*
AP	*Anti-Personnel*
ARP	*Air Raid Precautions*
ASW	*Anti-Submarine Warfare*
BDU	*Bomb Disposal Unit (historic term for EOD)*
Bgl	*Below Ground Level*
EOC	*Explosive Ordnance Clearance*
EOD	*Explosive Ordnance Disposal*
FP	*Fire Pot (German bomb)*
GI	*Ground Investigation*
HAA	*Heavy Anti-Air (gun battery)*
Ha	*Hectare (10,000m2)*
HE	*High Explosive*
IB	*Incendiary Bomb*
Kg	*Kilogram*
LAA	*Light Anti Air (gun battery)*
LCC	*London County Council*
LRRB	*Long Range Rocket Bomb (V2)*
LSA	*Land Service Ammunition*
Luftwaffe	*German Air Force*
OB	*Oil Bomb (German bomb)*
PM	*Parachute Mine (German bomb)*
RAF	*Royal Air Force*
RFC	*Royal Flying Corps*
RN	*Royal Navy (British)*
RNAS	*Royal Naval Air Service*
ROF	*Royal Ordnance Factory*
SAA	*Small Arms Ammunition*
SD2	*2kg AP bomb (German bomb)*
SI	*Site Investigation*
U/C	*Unclassified (German) bomb*
UP	*Unrotating Projectile (British 3" AA rocket)*
USAAF	*United States Army Air Force*
UX	*Unexploded*
UXB	*Unexploded Bomb*
UXO	*Unexploded Ordnance*
V1	*German Flying (pilotless) bomb - "Doodlebug"*
V2	*German LRRB - "Big Ben"*
WAAF	*Women's Auxiliary Air Force*
WWI	*World War One*
WWII	*World War Two*

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