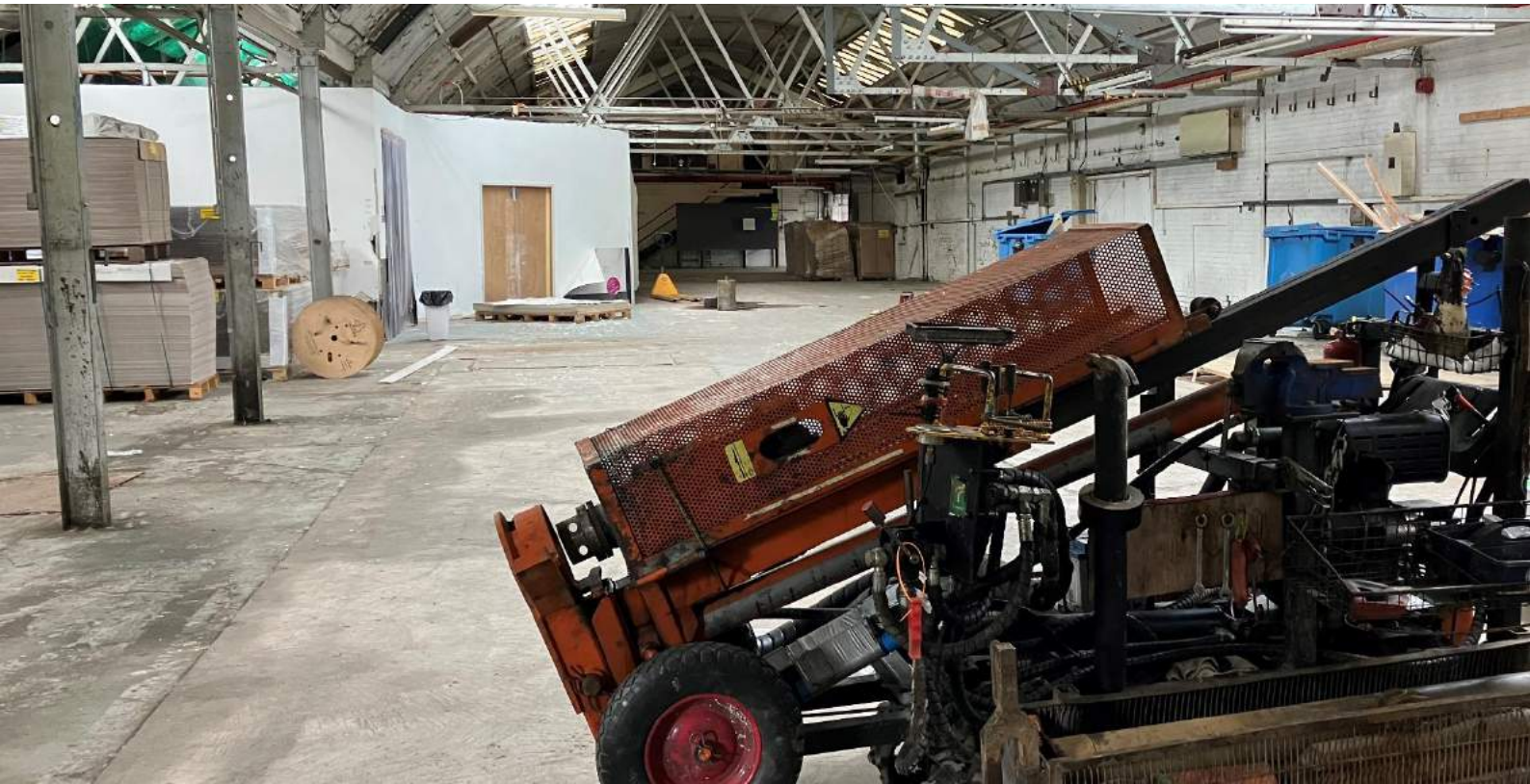




Intrusive Geoenvironmental and Geotechnical Site Assessment

Crabtree Lane, Manchester
Former Walkers Site
Crabtree Lane
Manchester
M11 4GU

July 2023

546629.0001.0000

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Executive Summary

TRC Companies Limited (TRC) was commissioned by Chancerygate Manchester Limited (the 'Client') to undertake a Tier 2 (formerly known as Phase II) Geoenvironmental and Geotechnical Site Assessment at the Former Walkers Site, Crabtree Lane, Clayton, Manchester, M11 4GU (hereafter referred to as the 'Site').

This Executive Summary is part of the complete report; and findings, opinions or conclusions in this Executive Summary are made in context with the complete report. TRC recommends that the user reads the entire report for all supporting information related to findings opinions and conclusions.

Executive Summary	
Site Details	
Client	Chancerygate Manchester Limited
Site Address	Crabtree Lane, Manchester, Former Walkers Site, M11 4GU
Site Area	M11 4GU 0.9 hectare (ha)
Proposed Development	The proposed development comprises three warehouse units; a large single unit in the east of the Site, Unit 5 (1,241m ²), and a further two structures in the north and south of the Site, each of which will house four adjoining warehouse units ranging in size from 372m ² to 757m ² . All units will have associated mezzanine floors, loading docks, parking and access roads.
Site Setting	
Current Site Use	The Site is currently an inactive plot of land, which comprises a series of adjoining warehouse buildings, formerly used as a print works.
Site History	Earliest available mapping (1848) shows that the Site comprised partially a brick works. By 1893 the Site had been redeveloped into a chemical works. In 1954 the Site was developed to reflect its current land use.
Expected Geology	Made Ground
	Superficial deposits – Till.
Expected Hydrogeology	Bedrock geology – Manchester Marls Formation at depth.
	Superficial deposits – Secondary (Undifferentiated) Aquifer)
	Bedrock geology – Secondary (B) Aquifer.
	The Site does not lie within a groundwater source protection zone.
Expected Hydrology	Groundwater is therefore considered to be not sensitive to contamination.
	The nearest surface water feature is the Ashton Canal, which is 58m south of the Site. It is unlikely to be in hydraulic connection with groundwater.
Unexploded Ordnance Risk Assessment	Surface water is therefore considered to be not sensitive to contamination.
	1 st Line Defence has assessed that there is a Medium Risk from items of German air delivered UXO. There is also an assessed Negligible Risk from Allied UXO across the Site.
	The following risk mitigation measures are recommended to support the proposed works at the Former Walkers Site, Crabtree Lane, Manchester:
	<u>All Works</u>
	UXO Risk Management Plan
	Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.
	<u>Open Excavations (trial pits, service pits, bulk excavations, strip foundations etc.)</u>

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	UXO Specialist On-site Support. <u>Boreholes and Piled Foundations</u> Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth. Please note proactive on-site UXO support/survey should not be necessary for any works taking place at the location of and down to the depths of significantly worked post-war made ground/post-war fill. The full report is provided in Annex H.
Investigation Findings	
Ground Conditions	The ground conditions comprised Made Ground with thicknesses of between 2.0m and 4.2m across the Site. Superficial deposits comprising interbedded granular and cohesive Till. The base of the Till was not confirmed during the investigation and was encountered to a maximum depth of 15.45m bgl.
Groundwater Conditions	According to the ground investigation and monitoring data, perched groundwater is anticipated sporadically within Made Ground and Glacial Till. Subartesian groundwater conditions were encountered at BH202 at 15.00m bgl.
Coal Mining	Coal measures were not encountered during the investigation. Review of the CON29M report obtained as part of TRC's Phase I Assessment and the SI findings indicate no risk from historic coal mining as a result of the significant depths coal measures underly the Site.
Geotechnical Assessment	
Geotechnical Hazards	The previous reports and ground investigation have identified a number of geotechnical hazards at the Site which relate to the proposed development. These are Made Ground to 4.2m bgl, soft clays / loose sands at depth, variable nature of Till, medium volume change potential of Till, soil desiccation in proximity to vegetation, ground aggressive to buried concrete, shallow groundwater and running sands phenomena, and are discussed in detail along with mitigation measures in section 6 of this report.
Foundations	Due to the problematic ground conditions near the ground surface which render shallow foundations on untreated ground unviable, ground improvement by way of Vibro Stone Columns (VSC), or Vibro Concrete Columns (VCC), followed by shallow foundations will likely be the most cost-effective foundation solution, subject to confirmation by a specialist ground improvement contractor. Details of the foundation options along with allowable bearing pressures, are discussed in Sections 6.3 and 6.4.
Floor Slabs	Use of ground bearing floor slabs following a ground improvement technique is likely to be the most cost-effective solution for the proposed structures, as further discussed in Section 6.5.
Excavations	Excavations for any shallow foundations, floor slabs, and laying services should be readily achievable using standard excavation plant. However, local hard surfacing, concrete obstructions such as old foundations and slabs encountered during the ground investigation within Made Ground, will require the use of a breaking apparatus. Details for anticipated excavations are provided in section 6.6.
Pavements	Assuming excavation formation soils will comprise Made Ground, or Till, an equilibrium CBR value of 2.5% is recommended for preliminary design purposes, based on a qualitative assessment and the findings of the ground investigation.

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	In-situ CBR testing at formation level prior to construction is recommended to confirm the design CBR values adopted. Details for proposed pavements are provided in section 6.7 of this report.
Buried Concrete	Considering the results of soil samples, a design sulphate class for location of DS-5 and an ACEC class for location of AC-5 is appropriate for Made Ground, and DS-1 and AC-1 is appropriate for Till. Should the Till be disturbed and exposed to surface conditions then an increase in design sulphate class for location to DS-4 and an ACEC class for location of AC-4 would be required. Details for buried concrete are provided in section 6.8 of this report.
Soakaways	Soakaway testing did not form part of the investigation scope of works. However, due to the significant thickness of the Made Ground, and the cohesive nature of the superficial geology encountered during the investigation the Site will likely be unsuitable for shallow soakaways.
Contaminated Land Assessment	
Human Health	A generic quantitative risk assessment has been undertaken to assess the risk from contaminants in soil to potential receptors. No exceedances of inorganic and organic compound were detected within the soils underlying the Site, which exceeded the GAC for a commercial end use. Based upon the proposed development plan it is assumed that there will be a presence of hard standing within the building footprint and across the majority of outdoor space, providing a physical barrier against contact with potential contaminants.
Controlled Waters	Groundwater and leachate samples obtained identified exceedances of the EQS and DWS for heavy metals. The Site is not located within a Source Protection Zone. The nearest surface water receptor is the Ashton Canal. The Site is not underlain by sensitive aquifers (secondary undifferentiated and Secondary B Aquifers). Due to the low sensitivity of underlying aquifers and the lack of a significant source of contamination, detailed consultation with the EA is unlikely to be required during planning to confirm whether further assessment of controlled waters is required.
Ground Gas and Organic Vapour	Gas monitoring indicates that the Site would be classified as Characteristic Situation 2 (low risk). It may be possible to zone the Site or reduce the risk rating, subject to further monitoring. There is not considered to be a risk from organic vapour.
Remediation	Based on the results of this assessment the following remediation/mitigation measures are considered to be required: • Demolition of existing buildings and associated infrastructure; • Removal of below ground structures; • Ground Gas protection to meet requirements for CS2; • Capping of landscaped areas with 450mm clean cover; • Installation of buried services in corridors of clean soil; and • Upgraded water supply pipework. Any works which have the potential to disturb asbestos must be undertaken in accordance with CAR 2012 and a Plan of Work will be required. An asbestos in soils management plan should be prepared to further assess risks associated with the asbestos in soils identified.
Recommendations	

Executive Summary

Based on the results of this assessment, the following geo-environmental requirements, to enable the proposed development are likely to be required:

- Delineation of ACM in soil at the location of BH102;
- Remediation Strategy and Verification Reporting;
- Materials Management Plan; and
- Water Pipe selection Risk Assessment.

Further delineation work could be undertaken prior to the construction phase, to quantify the risk (from ACM) at the location of BH102, inform the asbestos in soils management plan and any necessary mitigation measures.

Further ground gas monitoring could potentially be undertaken to determine whether the ground gas classification at the Site could be downgraded.

The selection of appropriate water supply pipework should be confirmed by the local water supply company. It will be necessary to undertake a pipe work selection risk assessment, to satisfy the local water authority and determine whether barrier pipe is required.

A remediation strategy and verification plan are likely to be required by the local planning authority.

Materials destined for off-site disposal to landfill may require further assessment in accordance with WM3 'Guidance on the classification and assessment of waste' (1st edition version 1.2 GB 2021) to determine their waste classification.

If materials are to be re-used on Site or imported from another development site, a materials management plan may be required in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice in order to demonstrate that the material is not a waste.

The input of a specialist ground improvement contractor should be sought at an early stage should a ground improvement solution be selected for the foundations, floor slabs, and external areas of the proposed development. The data contained in this report should be made available for an informed decision.

Additional investigation and laboratory testing of Made Ground samples may render possible the zoning of the Site with regards to buried concrete classification, in an attempt to reduce costs related to buried concrete class.

The recommendations of the detailed UXO risk assessment should be observed during any additional intrusive investigation and during construction.

1.0 Introduction

1.1 Appointment and Purpose

TRC Companies Limited (TRC) was commissioned by Chancerygate Manchester Limited (the 'Client') to undertake a Tier 2 (formerly known as Phase II) Geoenvironmental and Geotechnical Site Assessment at the Former Walkers Site, Crabtree Lane, Clayton, Manchester, M11 4GU (hereafter referred to as the 'Site').

A site location plan is presented as Figure 1 in Annex A.

The purpose of this Tier 2 report is to assess environmental and geotechnical considerations, predominantly with respect to ground conditions at the Site, which will be used to support future planning applications and design of redevelopment of the Site.

This Tier 2 report uses intrusive investigation methodologies to aid site characterisation and to inform the Client of potential environmental and geotechnical liabilities, identify risk, allow design development and inform cost estimates.

1.2 Proposed Development

The proposed development comprises three warehouse units; a large single unit in the east of the Site, Unit 5 (1,241m²), and a further two structures in the north and south of the Site, each of which will house four adjoining warehouse units ranging in size from 372m² to 757m². All units will have associated mezzanine floors, loading docks, parking and access roads.

The above assumed light industrial/commercial type development, will fall into geotechnical category 2 with respect to BS EN 1997 (Eurocode 7).

The end user sensitivity is considered Low for the proposed commercial/industrial end use.

A proposed development plan is presented as Figure 3 in Annex A.

1.3 Available Information & Standards

This report is based on the following information:

- Historical uses of the Site and surroundings;
- Current use and condition of the Site;
- Environmental setting in terms of geology, hydrogeology, hydrology and surrounding land uses;
- Relevant publicly available environmental records;
- Previous reports for the Site as listed in Section 2.6; and,
- Intrusive investigation including geoenvironmental and geotechnical sampling and testing.

This report was conducted with due regard to the following guidance and standards:

- The National Planning Policy Framework;
- BS5930:2015 (+A1:2020) Code of Practice for Ground Investigations;
- BS EN 1997 Eurocode 7;
- BS8485:2015 (+A1:2019) Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings;
- BS8576:2013 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds (VOCs);
- BS10175:2011 (+A2:2017) Investigation of Potentially Contaminated Sites – Code of Practice; and,
- Land Contamination: Risk Management (LCRM) 2020;

The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 1 to 5, together with Annexes A to E, comprise the Ground Investigation Report.

Preliminary geotechnical recommendations are presented in Section 6 and these may need to be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed.

1.4 Significant Assumptions

This report presents TRC's observations, findings, and conclusions as they existed on the date that this report was issued. This report is subject to modification if TRC becomes aware of additional information after the date of issue of this report that is material to its findings and conclusions.

The reliability of information provided by others to TRC cannot be guaranteed to be accurate or complete. Performance of this Tier 2 Geoenvironmental and Geotechnical Site Assessment is intended to reduce, but not eliminate, uncertainty of geoenvironmental and geotechnical conditions associated with the subject site; therefore, the findings and conclusions made in this report should not be construed to warrant or guarantee the subject site, or express or imply, including without limitation, warranties as to its marketability for a particular use. TRC found no reason to question the validity of information received unless explicitly noted elsewhere in this report.

1.5 User Reliance

This report was prepared for Chancerygate Manchester Limited. Reliance on this report by any other third party is subject to requesting and fully executing a reliance letter between TRC and the third party that acknowledges the TRC Standard Terms and Conditions with the Client, to the same extent as if they were the Client thereunder.

TRC has been provided with information from third parties for information purposes only and without representation or warranty, express or implied as to its accuracy or completeness and without any liability on such third parties part to revise or update the information. Where reliance has been provided by third parties to potential purchasers this is noted in our report.

2.0 The Site

2.1 Location

The Site comprises an approximate 0.9 ha plot of land located on the eastern side of Crabtree Lane, Manchester, centred on National Grid Reference E388756, N398228, approximately 3 miles from Manchester City Centre.

A Site location plan is presented as Figure 1 in Annex A.

2.2 Site Description

The Site is located within an area of predominantly commercial land use.

The Site is located to the east of Crabtree Lane and until recently the Site was occupied by a printworks, which has now been vacated, therefore, the Site is no longer operational. The buildings on Site comprised a relatively modern steel framed warehouse at the south of the Site and four older, brick-built warehouse buildings to the north, all of which are adjoining. A separate building, which appeared to be made from corrugated tin is present at the southeast corner of the Site.

An area of asphalt and concrete hardstanding is present at the west of the Site, with car parking spaces marked out. There is a roadway that occupies the land directly south of the southernmost warehouse, this provides access to the rear of the warehouse buildings, from the Site entrance and car parking spaces.

The Site has an average elevation of approximately 83.5m above Ordnance Datum (aOD). Topographically the Site is generally level however, there is a slight gentle slope downwards from the buildings to Crabtree Lane.

2.3 Surrounding Area

The Site is located within an area of predominantly commercial and residential land use. Land uses in the immediate vicinity include the following principal features:

Table 2.1: Summary of Surrounding Land Use

Direction	Land Use
North	Aldi supermarket with residential estate approximately 100m from the Site.
East	Retail stores and carpark with a residential estate approximately 150m from the Site.
South	Industrial units directly south of the Site followed by the canal. A residential estate is approximately 280m from the Site.
West	Industrial and undeveloped land.

2.4 Site Environmental Setting

2.4.1 Geology

The Site is underlain by variable thickness of Made Ground, over Glacial Till, over the Manchester Marl Formation at depth.

2.4.2 Hydrogeology

British Geological Survey (BGS) geological mapping and hydrogeological mapping presented by DEFRA (MAGIC website) indicate the following hydrogeological information for the Site:

Table 2.2: Summary of Hydrogeology

Geology	Geological Description	Aquifer Status	Aquifer Description
Superficial Deposits: Till	Clay, Sand and Gravel	Secondary (Undifferentiated) Aquifer	Rock deposits (or strata) with variable permeability and storage proprieties that are neither consistently Secondary A nor Secondary B.
Bedrock: Manchester Marls Formation	Mudstone	Secondary (B) Aquifer	Predominantly lower permeability strata which may in part have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fissures, thin permeable horizons and weathering.

The Site does not lie within a groundwater source protection zone (SPZ).

2.4.3 Hydrology

The nearest surface water feature is the Ashton Canal which is 58m south of the Site.

The Site is located in Flood Zone 1. Land within Flood Zone 1 has a low probability of flooding from rivers and the sea.

The Site is a medium risk for surface water flooding. Surface water flooding happens when rainwater cannot drain away through the normal drainage systems.

2.5 Summary of Site History

Earliest available mapping (1848) shows that the Site comprised partially a brick works. By 1893 the Site had been redeveloped into a chemical works. In 1954 the Site was developed to reflect its current land use.

2.6 Previous Investigations, Reports or Remediation

The following TRC site specific assessment has been reviewed and are referred to:

- TRC, report ref: 546629.0000.0000; Desk Based Geo-environmental and Geotechnical Site Assessment, June 2023.

The following site-specific assessments have been provided by the Client for review and are referred to:

- Phase 1 Environmental Due Diligence Report, Report Number 01A704444, March 2007, GVA Grimley LLP; and,
- Report on a Geo-Environmental Investigation at Crabtree Lane, Clayton, Manchester, M11 4GU, Report Number J2314/12/E, January 2013, Rogers Geotechnical Services LTD (RGS LTD).

The Client does not have reliance on the reports reviewed and information in this assessment is based solely on TRC gathered data.

Table 2.3: Summary of Previous Site Assessments

Report Details	Summary of Geo-environmental and Geotechnical Findings
TRC, report ref: 546629.0000.0000; Desk Based Geo-environmental and Geotechnical Site Assessment, July 2023	<u>Site History</u> Earliest available mapping (1848) shows that the Site comprised partially a brick works. By 1893 the Site had been redeveloped into a chemical works. In 1954 the Site was developed to reflect its current land use. <u>Expected Geology</u> Made Ground (unknown thickness) Superficial deposits – Glacial Till Bedrock geology – Manchester Marls Formation <u>Expected Hydrogeology</u> Superficial deposits – Secondary (Undifferentiated) Aquifer) Bedrock geology – Secondary (B) Aquifer The Site does not lie within a groundwater SPZ. <u>Initial Conceptual Site Model</u> On Site: Made Ground, historical use of the Site as a chemical works/print works dealing with chemicals at the Site could be a source of asbestos fibres in soil, heavy metals, polycyclic aromatic hydrocarbons (PAH), petroleum hydrocarbons, volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), sulphates, polychlorinated biphenyls and ground gases. Off Site: The historic landfill 100m south of the Site, adjacent substation, former bus station (directly north) and former chemical works within the vicinity are potential sources of heavy metals, polycyclic aromatic hydrocarbons (PAH), petroleum hydrocarbons, VOC, SVOC, sulphate, polychlorinated biphenyls (PCB's) and ground gases. <u>Potential Geotechnical Hazards</u> • Thick Made Ground due to past developments; • Infilled Ground, related to past excavations and brick field works; • Buried obstructions, such as old foundations and basements; • Ground conditions aggressive to buried concrete; • Volume change potential of soils; • Soil desiccation, in the vicinity of vegetation; and, • Settlement prone natural soils. <u>UXO</u> The Site is in an area affected by historical UXO risk. A Preliminary UXO Risk Assessment was carried out by 1st Line Defence which determined that it was not possible to negate the risk from UXO at this stage. <u>Coal Mining</u> The Landmark Envirocheck indicates that the Site is within an area that may be affected by coal mining. Further, according to the Coal Authority website the Site is located within the Coal Mining Reporting Area but outside the 'Development High Risk Area'. Therefore, a full Coal Mining Risk Assessment is not required.

Report Details	Summary of Geo-environmental and Geotechnical Findings
Phase 1 Environmental Due Diligence Report, Report Number 01A704444, March 2007, GVA Grimley LLP	• Undeveloped land and a chemical works in the 1890's. Since 1922 the whole Site has been in industrial use (chemical works, keg works and printing works) • Boulder Clay and Manchester Marl, underlain by Coal Measures. Coal seams at 700m depth. Made Ground likely to be present, thickness of deposit unknown. • The underlying Marl is classified as a non-aquifer. • Ashton (Under Lyne) Canal located approximately 80m to the south. Not located in an area of flood risk. • Low Environmental Sensitivity primarily due to presence of non-aquifer. • An asbestos survey has identified asbestos containing materials on Site.
Report on a Geo-Environmental Investigation at Crabtree Lane, Clayton, Manchester, M11 4GU, Report Number J2314/12/E, January 2013, Rogers Geotechnical Services LTD (RGS LTD)	• Fieldworks carried out by RGS LTD comprised of eleven hand and machine excavated trial pits and four cable percussive boreholes. Three monitoring standpipes were installed to 7m bgl. • Superficial deposits of Till (formerly Boulder Clay) and Manchester Marls Formation were the anticipated geology. • Made Ground was determined to continue to a depth between 1.9 and 4.1m bgl. • The Glacial Till was shown to be a depth of 9.95 to 10.45m bgl however the strata extended below the termination depths of investigated positions, so a final depth could not be determined. • A groundwater strike was recorded within one location at a depth of 7.3m. It should be noted that this water strike directly corresponds with the borehole encountering a granular layer below a cohesive stratum, therefore, it is considered that this water strike does not represent a phreatic surface, but perched water tables within the granular layer of till. • Chemical analysis on the soil samples taken during the site investigation showed PAH (dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene, benzo[g,h,i]perylene) all exceeded the Soil Screening Values for Commercial End Use compiled by WS Atkins plc; however they did not exceed CLEA criteria for Commercial End Use. • Concentrations of chromium, free cyanide, phenols and petroleum hydrocarbons (aliphatic C5 to C8 and aromatic C12 to C16) were below the detection limits for the tests. Detectable levels of all other contaminants were recorded, but these fell below the associated Soil Screening Values. • Carbon dioxide concentrations ranged between 0.4% and 7.7%. The source of the carbon dioxide revealed on the monitoring visits may be considered to be the Made Ground at the Site, however, in view of the granular nature of the fill at the site and the presences of a nearby landfill site, it is also possible that ground gases could be migrating from off-site sources. • No methane was detected in any of the boreholes in any of the monitoring visits. • Recommendations for during the construction phase include: ○ Beneath buildings, pavements and hard-standings clean inert granular sub-base should be employed. ○ Due to the levels of CO₂ and according to Table 8.6, Typical scope of gas protection measures, of CIRIA report C665, one to two levels of protection are considered necessary and should include: ▪ Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM. ▪ Beam and block or precast concrete slab and 2000g DPM / reinforced gas membrane. ▪ Possible underfloor venting. For buried concrete, the results of the sulphate and pH testing indicate that the design sulphate class for the site should be DS-3.

3.0 Ground Investigation

3.1 Scheduled Scope of Works

The scheduled TRC Tier 2 investigation scope of works comprised:

- Five cable percussive boreholes (BH101 – BH103, BH202 + BH203) to a maximum depth of 15 m;
- Two days (up to 10 locations) of windowless sample boreholes to a maximum depth of 5 m;
- In-situ logging, ground sampling and testing;
- Field screening for contamination using a Photo-Ionisation Detector (PID);
- Construction of six gas and groundwater monitoring wells;
- Field monitoring of bulk ground gases and groundwater levels on four occasions; and,
- Collection of groundwater samples for laboratory testing.

3.2 Investigation Rationale

The ground investigation was designed by TRC on behalf of the Client to gather information on the geoenvironmental and geotechnical ground, groundwater and ground-borne gas conditions at the Site.

The TRC investigation aimed to gain good general coverage of the Site.

Table 3.1: Summary of Exploratory Hole Locations

Exploratory Hole	Location
BH101	Located on east of main building on soft landscaping
BH102	Located on southwestern corner of site
BH202	Located on southwestern corner of site
BH203	Located on north-western corner / entrance to Site
WS101	Inside building, northern area
WS102	Inside building, north-eastern area
WS103	West of the building
WS104	Centre of the building
WS105	Located on eastern boundary of Site
WS106	Located adjacent electricity substation on western area
WS107	Inside building, southern area
WS108	Located inside the corrugated tin building at the south-eastern corner

3.3 Investigation Methodology

3.3.1 Ground Investigation

The TRC Tier 2 investigation was conducted at the Site on 23rd - 26th May and 12th – 14th June 2023.

TRC commissioned GSS and DMW Drilling (drilling contractors) to undertake the cable percussive and windowless sampling drilling at the Site. The drilling works were overseen by a TRC engineer who performed field assessment and logging of the exploratory holes.

The works included the following key actions:

- Review of available underground services plans for the Site;
- Each of the proposed exploratory hole locations was cleared using a Cable Avoidance Tool (CAT) and ground penetrating radar (GPR) by an independent utility surveyor;

- Cable Percussive and Windowless Sampling drilling was performed at each location by the drilling contractors, including in-situ geotechnical testing;
- A UXO Engineer supported the safe completion of the exploratory holes by use of a magnetometer ahead of drilling;
- On-site ground logging, testing, and assessment of potential indicators of contamination;
- Field screening using a PID;
- Collection of soil and groundwater samples for environmental and geotechnical laboratory analysis;
- Construction of gas and groundwater monitoring wells in seven borehole locations, WS101, WS104, WS106, WS108, BH102 and BH202;
- WS102, WS103, WS105, WS107, BH101 and BH203 were backfilled with arisings; and,
- Surveying of the exploratory holes final locations.

The following alterations to exploratory hole depths or positions were made during the course of the ground investigation:

- WS102, WS107 and WS108 were terminated at 1.40m, 3.00m, 2.25m bgl, respectively, due to refusal on obstructions or borehole collapse (WS107);
- WS103 were cancelled due to time restrictions and only hand pits to 1.20m bgl were conducted;
- BH101 was cancelled due to time restrictions, however BH101 was drilled during a second round of drilling;
- BH101 were terminated at 5.45m bgl respectively, due to encountering a dense stratum;
- A second round of cable percussive drilling added BH202 and BH203, with depth of 15.00m and 10.00m bgl, respectively. BH202 was added 3.00m away from BH102 and drilled down to 15.00m bgl.

The exploratory hole location plan for the ground investigation undertaken, is presented as Figure 2 in Annex A.

The exploratory hole logs are presented in Annex C and include the in-situ sampling and testing undertaken at the Site.

3.3.2 Groundwater and Ground Gas Monitoring

The ground conditions encountered with respect to the response zone of the monitoring installations are summarised in the table below.

Table 3.2: Monitoring Wells Summary

Exploratory Hole	Response Zone (m bgl)	Response Zone Strata (m bgl)	
WS101	0.80 – 2.80	0.18 – 3.20	Made Ground
WS104	0.80 – 2.80	0.17 – 3.50	Made Ground
WS106	0.50 – 2.00	0.15 – 3.80	Made Ground
WS108	1.00 – 1.80	0.25 – 2.25	Made Ground
BH102	4.00 – 9.00	4.00 – 9.00	Till
BH202	5.00 – 15.00	5.00 – 15.00	Till

Groundwater and ground gas monitoring was conducted by a TRC technician on four occasions. The dates of the monitoring visits were 7th, 13th, 27th June and 4th July 2023.

During each visit, groundwater elevation and potential presence of any free phase oils was measured using an oil/water interface probe. Gas monitoring was undertaken using a portable gas analyser at each monitoring

well head. The field assessment gathered data relating to the concentrations of permanent ground gases (e.g. methane, carbon dioxide, carbon monoxide and oxygen).

Groundwater sampling was also undertaken at BH102, WS101 and WS104 using a dedicated disposable bailer/low flow monitoring techniques.

3.4 Geotechnical In-Situ Testing

In-situ testing was undertaken for geotechnical purposes. The details of the in-situ test results are presented in the logs within Annex C and in the field data within Annex D.

The site based geotechnical testing is summarised in the table below.

Table 3.3: In-situ Tests (Geotechnical)

Test Type and Standard	Number
Standard penetration test (BS EN ISO 22476-3:2005+A1:2011)	53
Hand penetrometer (UK Specification for Ground Investigation, 3 rd Edition)	8

Any limitations to the in-situ testing that require consideration during the evaluation of the data are described in the following paragraphs.

Although the Standard Penetration Test (SPT) is a standardised test, uncorrected SPT 'N' values display a considerable amount of scatter. Calibrated SPT hammers were used during the ground investigation and in our evaluation, presented in Section 5, the results have been normalised to 'N₆₀' in accordance with Eurocode 7.

An elevated SPT N value, likely due to encountering an obstruction within Made Ground was recorded at 1.20m bgl at WS102. As discussed in Section 5, these are not considered representative of the stratum as a whole and have been discounted from subsequent analysis.

The following SPTs straddle two strata and so are considered to be representative of neither and have been discounted from subsequent analysis:

- BH101 at 4.00m bgl;
- BH202 at 10.50m;
- WS101 at 3.00m bgl; and,
- WS105 at 2.00m bgl.

The pocket penetrometer apparatus, due to operational reasons, provides only an estimate of the unconfined compressive strength and the undrained shear strength as is it less precise than other test methods, especially when undertaken on samples obtained from dynamic sampling equipment. Given the limitations of this test method, in isolation, it is only considered indicative of the undrained shear strength for foundation purposes. However, it can provide useful information on the relative intact strength of soils so as to assist with the assessment of desiccation.

The above factors have been considered in the appraisal of geotechnical results presented in Section 5.

3.5 Geotechnical Laboratory Testing

Laboratory testing was undertaken for geotechnical purposes.

The geotechnical laboratory testing is summarised in the table below.

Table 3.4: Laboratory Tests (Geotechnical)

Test Type and Standard (BS 1377 unless stated differently)	Number
Water (moisture) content (BS EN ISO 17892-1)	8
Bulk density (BS EN ISO 17892-2)	3
Liquid and plastic limits and plasticity index (BS EN ISO 17892-12)	7
Particle size distribution - wet sieving (BS EN ISO 17892-4)	9
Single stage 100mm UU triaxial compression test	3
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	14
Total sulphur content (BRE SD1 2005)	5
Acid soluble sulphate content (BRE SD1 2005)	5
Soil pH (BRE SD1 2005)	14

As with in-situ testing, it is necessary to consider the limitations associated with any laboratory testing and to review any potentially anomalous results. In all geotechnical tests the specimen is selected from a much larger volume of material which may have an inherent degree of variability, particularly in Made Ground.

Water content determinations on disturbed samples may not be representative due to the disturbance arising from the sampling process. Moisture content results can be influenced by climatic factors, and it cannot be guaranteed that the values determined at the time of investigation will be the same as those at the time of construction.

Obtaining coarse grained soils from cable tool or windowless boreholes can result in a loss of materials due to the nature of the sampling process. This can have an influence on the results of particle size distribution analyses.

Determination of the undrained shear strength can be affected by sample disturbance. Whilst this is reduced by the use of UT100 sampling equipment, it cannot be fully eliminated and requires due consideration in appraising the results, especially where an elevated number of blows were required to retrieve the sample. In addition, an element of sample disturbance cannot be avoided when extruding and preparing samples in the laboratory.

Determination of the undrained shear strength can also be affected by the presence of fissures or laminations in soils. The application of a suitable confining pressure in the test can reduce this, but the results can still be affected to a certain degree.

The above factors have been considered in the appraisal of the geotechnical results given in Section 5.

The full set of laboratory geotechnical results is presented in Annex G.

3.6 Environmental Laboratory Analysis

A total of 21 soil samples were collected for environmental analysis during the exploratory works. All soil samples were packed in laboratory provided containers and delivered to I2 Analytical (I2) for chemical analysis.

All soil samples were collected to provide environmental data on the quality of near surface and shallow soils beneath the Site. Representative samples of Made Ground and natural deposits were collected where feasible. The analytical suite of soils included the following parameters:

- Asbestos (Made Ground/Fill Materials only);

- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH);
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG);
- Volatile organic compounds (VOC); and,
- Polychlorinated biphenyl (PCB).

One asphalt sample from the pavement was also collected and sent to I2 and analysed for the following:

- Polycyclic aromatic hydrocarbons (PAH).

Leachate samples were prepared from selected soil samples by I2 and analysed for the following:

- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH);
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG); and,
- Volatile organic compounds (VOC).

Groundwater samples were collected from three of the boreholes. The samples were sent to I2 and analysed for the following:

- Heavy metals suite;
- Polycyclic aromatic hydrocarbons (PAH);
- Total petroleum hydrocarbons – Criteria Working Group (TPH-CWG); and,
- Monoaromatics and Oxygenates.

The full set of chemical results are presented in Annex F.

4.0 Ground Conditions

4.1 Ground Profile

The investigation observed that the soils underlying the Site generally comprised the following:

Table 4.1: Ground Profile

Stratum	From		To		Thickness (m)
	m bgl	m aOD ¹	m bgl	m aOD ¹	
Made Ground	0.00	84.00	2.00 - 4.20	82.00 – 79.80	2.00 – 4.20
Till	2.00 – 4.20	82.00 – 79.80	>15.45	<68.55	>13.25

1. Assuming a ground level of 84.00m aOD across the site.

The Site was mantled a variable thickness of concrete or bituminous hardstanding underlain by granular, locally cohesive deposits of Made Ground to a maximum recorded depth of 4.20m, underlain by cohesive and granular deposits of Till, encountered to the base of all exploratory holes, and a maximum depth of 15.45m bgl. The base of Till was not confirmed during the investigation and bedrock geology was not encountered.

The ground conditions encountered correspond with the publicly available records of ground conditions published by the British Geological Survey (BGS) and reported in previous reports for the Site. Published BGS borehole records within/near the Site area found similar results.

4.2 Made Ground

Made Ground was encountered in all of the exploratory holes to depths of between 2.00m (BH203) and 4.20m bgl (BH101). Thicker Made Ground than that encountered during the ground investigation cannot be discounted across the Site as the base of the material was not confirmed at locations WS102, WS107 and WS108, due to refusal on obstructions or collapse of the borehole at depth of between 1.20m and 3.00m bgl.

Made Ground at the Site was predominantly granular and comprised either dark grey / black silty gravelly sand or grey very sandy gravel. Sand was fine to coarse. Gravel was angular to rounded, fine to coarse of clinker, slag, asphalt, brick. Cobble content of brick varied locally. At location WS106 (2.80m – 3.80m bgl) Made Ground was cohesive in nature, comprising black sandy slightly gravelly clay. Sand was fine to coarse grained gravel was angular to rounded, fine to coarse grained of brick.

4.3 Till

Superficial deposits of Till were encountered at all locations not terminated in overlying Made Ground to a maximum depth of 15.45m bgl (BH202), recording a maximum thickness of >13.25m. The base of the stratum was not confirmed during the investigation.

Till was found to be highly variable both vertically and laterally across the Site, comprising heterogeneous deposits of interbedded granular and cohesive material. Till comprised either soft to very stiff brown sandy slightly gravelly CLAY or loose to very dense brown silty SAND or loose to very dense brown silty sandy GRAVEL. Sand was fine to coarse. Gravel was very-angular to well-rounded, fine to coarse of flint.

4.4 Groundwater

Water strikes observed during the site works and the results of the monitoring visits are summarised in the table below.

Table 4.2: Groundwater Observations

Exploratory Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m aOD	m bgl	m aOD	m bgl	m aOD	m bgl	m aOD
BH202	15.30	68.70	10.00	74.00				
BH101	3.20	80.80	3.00	81.00	NA	-	NA	-
BH102	NR	-	-	-	6.32	77.68	6.48	77.52
WS101	NR	-	-	-	2.20	81.80	2.48	81.52
WS104	NR	-	-	-	2.37	81.63	2.61	81.39
WS106	NR	-	-	-	Dry	<82.00	Dry	<82.00
WS108	NR	-	-	-	Dry	<82.00	Dry	<82.00

NR = None Recorded

During the ground investigation, groundwater was encountered locally at BH101 (at 4.00m bgl) in the Made Ground and BH202 at 15.30m bgl within the Till.

During subsequent gas and groundwater monitoring, groundwater resting levels were recorded between 2.20m bgl and 6.48m bgl.

The groundwater monitoring data are presented in Annex D.

According to the ground investigation and monitoring data, groundwater is anticipated sporadically within Made Ground and Glacial Till. Subartesian groundwater conditions were encountered at BH202 at 15.00m bgl.

Groundwater may be subject to seasonal variations especially after periods of prolonged rain or drought.

4.5 Visual and Olfactory Evidence of Contamination

Visual and olfactory evidence of contamination was encountered during the ground investigation, as detailed in table below.

Table 4.3: Evidence of Contamination

Exploratory Hole	Depth (m bgl)	Comments	
WS101	0.18 – 3.20	Made Ground	clinker ash
	2.20 – 2.30	Made Ground	oily material & odour
WS102	0.20 – 1.40	Made Ground	clinker ash
WS104	0.17 – 3.50	Made Ground	clinker ash
WS105	0.20 – 2.40	Made Ground	clinker ash
WS107	0.15 – 3.00	Made Ground	clinker ash
WS108	0.25 – 2.25	Made Ground	clinker ash
BH101	0.00 – 4.25	Made Ground	clinker ash
BH102	0.25 – 2.90	Made Ground	clinker ash
BH202	0.25 – 2.80	Made Ground	clinker ash
BH203	0.20 – 2.00	Made Ground	clinker ash

5.0 Geotechnical Assessment.

5.1 Strata Properties

5.1.1 Made Ground

Nineteen SPTs conducted in the Made Ground, yielded N_{60} values ranging between 0 (self-weight penetration) and 21, indicating the variable nature of the material.

Five particle size distribution tests undertaken on samples of the Made Ground recorded 0% cobbles, 34% to 51% gravel, 37% to 47% sand and 6% to 30% clay/silt.

Two moisture content tests undertaken on samples of the Made Ground recorded values in the range of 17.2% to 29.8%

5.1.2 Till

Seventeen SPTs conducted in granular Till deposits, yielded N_{60} values ranging between 4 and 51. A further twelve SPTs conducted in cohesive Till deposits, yielded N_{60} values ranging between 11 and 51 highlighting the variable engineering properties of the stratum. The SPT N_{60} values do not generally increase with depth indicating the inconsistent engineering nature of Till. SPT N_{60} values are plotted against depth in Figure 4 in Annex A.

Five particle size distribution tests undertaken in the Till recorded 0% cobbles, 0% to 14% gravel, 27% to 96% sand and 2% to 70% clay/silt. These results indicate the high variability of the stratum.

Twelve moisture content tests undertaken in the Till recorded values in the range of 12.5% to 40.1%.

Seven Atterberg limits tests undertaken in the Till recorded values in the range of 27% to 50% for the liquid limit, 14% to 31% for the plastic limit, and 11% to 24% for the plasticity index. The modified plasticity index was 11% to 23%. The results indicate that the Till is of low to high plasticity and of low to medium volume change potential (VCP) in accordance with NHBC guidelines. Desiccation could exist at the Site, given a large number of mature trees present at the perimeter of the Site.

Two unconsolidated undrained triaxial tests recorded undrained shear strengths of 151kN/m² to 222kN/m².

The SPT N_{60} values and undrained shear strength values (C_u) both increase with depth. Based on the correlation between N_{60} and the undrained shear strength and plasticity index for insensitive clays (after Stroud and Butler, 1975) and previous experience, a relationship of $C_u = 5 \times \text{SPT } N_{60}$ is considered appropriate for cohesive deposits of Till. Both the SPT and triaxial test data are represented graphically in Figure 5 in Annex A, from which C_u values of between 56 kN/m² and 254 kN/m² are indicated for cohesive Till deposits at the Site.

Table 5.1: Summary of Ground Parameters for Till

Soil Parameters	Number of Tests	Range of Results	Characteristic Value ¹
Liquid Limit (%)	7	41-50	50
Plastic Limit (%)	7	18-31	31
Plasticity Index (%)	7	19-23	23
Modified Plasticity Index (%)	7	14-23	23
Plasticity	7	CL - CH	CH
Volume Change Potential (NHBC)	7	Low to Medium	Medium

Soil Parameters	Number of Tests	Range of Results	Characteristic Value ¹
Bulk Unit Weight (Mg/m ³)	2	2.14	2.14
SPT N ₆₀ Values	29	4-51	Refer to Figure 4 in Annex A
Undrained Shear Strength (kN/m ²)	As per main text	As per main text	Refer to Figure 5 in Annex A

1. Cautious estimate

5.2 Buried Concrete

Fourteen soil samples, comprising seven from the Made Ground and seven from the Till, were subjected to pH and water soluble sulphate determinations.

The characteristic value of water soluble sulphate was 1400 mg/l for Made Ground, and 480 mg/l for Till.

Five soil samples, two from the Made Ground and three from the Till, were subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack. Two of the oxidisable sulphides values calculated for Made Ground (0.43% – 2.44%) and two for Till (0.43% - 1.32%) were in excess of 0.3%. Consequently, the results are considered indicative of significant risk from this form of concrete attack. A modification to DS class is therefore proposed to DS-5 for Made Ground and DS-4 for Till, should the latter be exposed to surface conditions.

The characteristic value of pH was 5.8 for Made Ground, and 6.8 for Till.

Overall, with reference to the BRE Digest SD1 (2005), and considering the results of soil samples, a design sulphate class for location of DS-5 and an ACEC class for location of AC-5 is appropriate for Made Ground, and DS-1 and AC-1 is appropriate for Till. Should the Till be exposed to surface conditions then an increase in design sulphate class for location to DS-4 and an ACEC class for location of AC-4 would be required.

6.0 Geotechnical Recommendations

6.1 General

It is proposed to develop the Site for three commercial warehouse structures, a large single unit in the east of the Site and a further two warehouse structures in the north and south of the Site. The structures in the north and south will house four adjoining units, respectively. Current proposals are indicated in Figure 2 in Annex A.

Details of the proposed structures, anticipated loadings and serviceability criteria were under development at the time of writing of this report.

The primary purpose of this report is to identify risk, allow design development and inform cost estimates. This report does not constitute a detailed design report for the proposed development.

For the purposes of this assessment, TRC assumed that finished ground levels will be at, or close to, existing ground levels. If these levels are changed, then this assessment should be revisited to examine potential changes in recommendations.

6.2 Geotechnical Hazards

The previous reports and the current ground investigation have identified several potential geotechnical hazards at the Site which relate to the proposed development. These are summarised below and discussed in more detail in the following Sections of this report along with mitigation measures where appropriate.

- Made Ground to depths up to 4.20m. Thicker Made Ground across the Site cannot be ruled out;
- Soft clays/loose sands to depths of at least 10.00m;
- Variable nature of Till deposits vertically and laterally across the Site;
- The medium volume change potential of cohesive Till;
- Soil desiccation near vegetated areas;
- Ground aggressive to buried concrete;
- Shallow groundwater level; and,
- Running sands phenomena.

6.3 Foundations

As described in Section 4, the Site is underlain by Made Ground to a maximum recorded depth of 4.20m bgl underlain by Till to a maximum proven depth of 15.45m bgl, with the latter comprising soft clays/loose sands locally to at least 10m bgl. Thicker deposits of Made Ground and soft/loose Till cannot be ruled out across the Site.

The Made Ground, unless treated to an appropriate specification, are not considered competent foundation strata due to lithological variability, poor engineering properties and susceptibility to settlement.

For shallow foundations to be considered for the proposed structures a ground improvement scheme will be required to at least 5m bgl. The final bearing capacity of the treated ground for shallow foundations to be adopted will be depended on the method and details of the ground improvement utilized at the Site. Following successful ground improvement at the Site, shallow pad or strip foundations on higher capacity treated ground should be possible subject to confirmation by a specialist contractor.

Unless the finally selected treatment scheme deals with the volume change potential of the soils on-Site, in the vicinity of retained, removed or proposed vegetation, final foundation depths and heave precautions are recommended to be determined in accordance with Chapter 4.2 of the NHBC Standards, based on a 'medium' volume change (shrink-swell) potential for the Till. The foundations should also be taken below any desiccated soils and 300mm below any live roots, as may be encountered during construction.

It is understood that the Client is in favour of a ground treatment solution therefore a piling foundation option, although feasible, has not been discussed in this report.

6.4 Ground Improvement

Ground improvement may enable shallow foundations to be used for the proposed structures. The advice of reputable specialist contractors experienced in the ground conditions discussed in this report should be sought. They should be responsible for the selection of appropriate equipment and the final design of the treatment.

Made Ground was encountered up to 4.20m depth; thicker Made Ground cannot be ruled across the Site. The Made Ground is not considered a suitable bearing stratum due its inherent metastable nature and poor engineering properties.

An additional geotechnical hazard to consider was the presence of loose granular Till encountered under Made Ground at depths of between 8m and 10m bgl. Soft/loose Till would yield small ABPs and would be prone to significant settlement if these ABPs were exceeded. However, it is considered probable this loose granular material is at sufficient depths to not be influenced by the pressure bulbs of any shallow foundations at the Site, although these findings should be considered by a specialist ground improvement contractor prior to finalising a ground improvement scheme.

On this basis the Site will require ground improvement to a depth of at least 5m bgl. Ground improvement beyond this depth cannot be excluded should thicker Made Ground deposits be encountered to greater depths.

The ground conditions encountered at the Site would likely be suitable for improvement via methods such as Vibro Stone Columns (VSC), or Vibro Concrete Columns (VCC), subject to confirmation by a specialist contractor. Alternatively, should associated ground vibration present an issue for neighbouring structures, methods such as Controlled Modulus Columns (CMC) could be utilized at the Site. Upon treatment an allowable bearing capacity in the region of 125-150kN/m² is anticipated. The presence of obstructions (due to past developments) or cobbles within the Made Ground (found during past SI) should be considered in the selection of the most appropriate treatment method and equipment.

The local presence of subartesian groundwater within granular Till layers, should be considered in the selection of the most appropriate treatment method.

6.5 Floor Slabs

Use of ground bearing floor slabs following a ground improvement technique, such as (indicative at this preliminary stage) excavation, replacement and recompaction of any remaining Made Ground to an appropriate specification, is likely to be the most cost-effective solution, provided that the required settlement tolerances can be achieved and the finally selected ground treatment solution deals with the 'medium' volume change (shrink-swell) potential of the cohesive Made Ground, in the vicinity of any retained, removed, or proposed vegetation. Such matters, along with the potential heave of foundation soils in the long term should be considered as recommended in NHBC Standards Chapter 4.2.

Heavily loaded areas such as concrete yards and loading areas where less ground settlement can be tolerated, could be constructed on previously treated ground and/or reinforced subbase with geogrids/geotextiles to satisfy design criteria. The treatment method required in this case would be decided during the final design stage.

Advice from a specialist ground treatment contractor should be sought once the required floor loadings and settlement tolerances are known.

6.6 Excavations

Excavations for any shallow foundations, floor slabs, and laying services should be readily achievable using standard excavation plant.

For any load bearing formations, careful inspection should be undertaken to ensure placement in competent natural strata unless ground treatment has been carried out and properly validated. Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground.

Boreholes locally had to be terminated due to instability caused by running sands. Stability of excavation faces in Made Ground and Till cannot be relied on and allowance should be made for battering faces back to a safe angle of repose or providing shuttering. Support or battering of the excavation faces to a safe angle of repose will be required for all excavations where man entry is necessary, the nature and extent of which will need to be evaluated under CDM regulations.

Shallow groundwater is anticipated at the Site at depths of between 2.20m and 6.48m bgl within Made ground and Till. Deeper (more than 15m bgl) sub artesian groundwater conditions mainly within the granular layers of Till have also been indicated by the ground investigation. Groundwater ingress control measures will need to be assessed during the construction. Allowance should be made for some pumping during construction to keep any shallow excavations dry.

Groundwater levels vary seasonally, and the timing of the construction programme may influence the volumes of groundwater that need to be managed. The contractor should also consider the impact of weather and potential for rainwater and surface run-off to accumulate within excavations.

6.7 Pavements

Due to the variability of the natural ground conditions and the thickness of Made Ground encountered, pavement surfaces in light loaded car park areas should be constructed in flexible materials such as bituminous compounds or block paving which are more easily able to accommodate ground movement and can be more easily repaired. Heavily loaded areas such as concrete yards and loading areas where less ground settlement can be tolerated, could be constructed on previously treated ground and/or reinforced subbase with geogrids/geotextiles to satisfy design criteria.

It is recommended that any fill proposed is placed and compacted in accordance with a suitable specification based on the Specification for Highway Works (SHW 600 series). The formation level should be rolled and inspected for any soft or loose material. These materials should be removed and replaced with granular fill placed and compacted in accordance with a suitable specification.

Assuming excavation formation soils will comprise Made Ground, or Till, an equilibrium CBR value of 2.5% is recommended for preliminary design purposes, based on a qualitative assessment and the findings of the ground investigation.

In-situ CBR testing at formation level prior to construction is recommended to confirm the design CBR values adopted.

6.8 Buried Concrete

In the consideration of sulphate attack on buried concrete, reference has been made to BRE Digest SD1 (2005) which classifies the Site as brownfield with mobile groundwater conditions. Considering the results of soil samples, a design sulphate class for location of DS-5 and an ACEC class for location of AC-5 is appropriate for Made Ground, and DS-1 and AC-1 is appropriate for Till. Should the Till be disturbed and exposed to surface conditions then an increase in design sulphate class for location to DS-4 and an ACEC class for location of AC-4 would be required.

6.9 Soakaway Potential

Soakaway testing did not form part of the investigation scope of works. However, due to the significant thickness of the Made Ground, and the cohesive nature of the superficial geology encountered during the investigation the Site will likely be unsuitable for shallow soakaways.

6.10 Recommendations for Further Work

The preceding sections have attempted to provide recommendations for future developments, but further investigation and analysis will be required to fully quantify the risks and allow detailed design once development proposal are available. Further investigation should comprise:

- Additional investigation and laboratory testing of Made Ground samples may render possible the zoning of the Site with regards to buried concrete classification, in an attempt to reduce costs related to buried concrete class.

7.0 Human Health Risk Assessment

7.1 Soil Assessment

To appraise the significance of the concentrations reported by laboratory testing, TRC has assessed each contaminant species that is elevated above the laboratory method detection limits (MDL) against published screening criteria referred to as Generic Assessment Criteria (GAC). GACs are derived from the following reference material:

- Land Quality Management Limited and Chartered Institute of Environmental Health (November 2014), the LQM/CIEH S4ULs for Human Health Risk Assessment. Document reference: S4UL3435;
- Development of Category 4 Screening Levels for assessment of land affected by contamination – SP1010 (September 2014);
- LQM S4ULs: evaluation of 2017USEPA Toxicological Review of Benzo(a)pyrene; and,
- LQM/CIEH S4ULs for Nickel according to land use (Revised August 2015).

TRC has selected GACs for a commercial or industrial, based on the proposed development comprising commercial/industrial end use.

A conservative value of 1% of soil organic matter (SOM) has been assumed based on the soil type.

A summary of the laboratory data and the screening tables with relevant GACs is presented in Annex F.

7.2 Heavy Metals

Minor concentrations of heavy metals were detected in soil samples (both Made Ground and natural soils). None of the concentrations exceeded the GACs.

7.3 Hydrocarbons

Minor concentrations of hydrocarbons were detected in soil samples (both Made Ground and natural soils). None of the concentrations in soil samples exceed the GACs. Subsequent sampling of BH102, WS101 and WS104 showed no detection of hydrocarbons.

One sample of asphalt type material of the hardstanding (at location BH203) was sampled to test for the presence of polycyclic aromatic hydrocarbons (PAHs). The laboratory analysis reported elevated concentrations of six PAHs exceeding the GAC. The exceedances are summarised in the below table.

Table 7.1: Summary of PAH Exceedances in pavement sample

Contaminant	Commercial GAC (mg/kg)	Sample Concentration (mg/kg)
Naphthalene	190	1,500
Benzo(a)anthracene	170	1,300
Chrysene	350	1,200
Benzo(b)fluoranthene	44	980
Benzo(a)pyrene	36	990
Dibenz(a,h)anthracene	3.5	130

7.4 Asbestos

Asbestos fibres in soil were encountered within two samples analysed in the Made Ground (WS105 and BH101). The samples containing asbestos were found to contain chrysotile type fibres in soil. Asbestos quantification was undertaken on these samples and identified a concentration of <0.001 fibres in soil.

Asbestos fibrous debris in soil were encountered within two samples of Made Ground. The samples containing asbestos were found to contain chrysotile and amosite (WS108) and chrysotile and crocidolite (BH102) type fibres in soil. Asbestos quantification was undertaken on these samples and identified a concentration of 0.031% (WS108) and 8.33% (BH102) fibres in soil.

7.5 Volatile Organic Compounds

Three soil samples were tested for VOC's, due to suspected elevated levels of contamination. However, no VOC's were identified above the laboratories limit of detection.

7.6 Polychlorinated Biphenyls

One soil sample was tested for PCB's (WS106 at 0.7m bgl), due to this exploratory point being close to an old substation located adjacent to the Site. No PCB's were identified above the laboratories limit of detection.

7.7 Discussion

One sample of asphalt type material (pavement surfacing) collected from the cored location of BH203 exceeded six polycyclic aromatic hydrocarbons (PAHs) values, which could potentially classify the material as hazardous. Values exceeded were naphthalene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene and dibenz(a,h)anthracene. Whilst this is based only on one sample, if asphalt type material is to be removed from Site as part of the redevelopment, it is recommended that further testing is undertaken to confirm the waste classification.

There were no exceedances of the GAC in soils for the proposed commercial end use. Asbestos fibres and fibrous debris were identified within four samples of Made Ground. Two samples (WS105 and BH101 at 1.00m and 2.50m bgl respectively) detected loose chrysotile fibres of less than 0.001%. The other two samples (WS108 and BH102 at 1.60m and 0.80m bgl respectively) detected loose fibres debris of chrysotile & amosite (0.031%) and chrysotile & crocidolite (8.33%) respectively.

The asbestos identified in the samples is considered to pose a low risk to future site users as the Site will be predominantly covered in buildings or hardstanding if used as commercial property, however groundworkers could be at risk during the construction phase. Future maintenance workers could also be at risk if working in buried service excavations. Suitable Personal Protective Equipment (PPE) should be used to mitigate risk during the construction phase and during any future maintenance work.

8.0 Controlled Waters Risk Assessment

To appraise the significance of the soil leachate concentrations recorded, TRC has assessed each contaminant species that is elevated above the laboratory LOD against the following published guidance values:

- Drinking Water Standards England and Wales (2000) (amended);
- Environmental Quality Standards (EQS) for freshwater; and,
- World Health Organisation (WHO) Guidelines.

Groundwater monitoring recorded groundwater in three monitoring wells (WS101, BH102 and BH202) ranging from 2.24 mbgl to 6.48 mbgl. No free phase oils or hydrocarbons odours were identified. Groundwater was sampled on one occasion and soil samples were obtained for leachate analysis.

It should be noted that leachate derived from soils are not considered to be representative of groundwater conditions at the Site and can only provide an indication of leachability.

8.1 Groundwater Assessment

The laboratory analysis reported elevated concentrations of arsenic exceeding the UK DWS in one soil leachate sample collected. Two exceedances of UK DWS were detected in the ground water samples. The exceedances are summarised in the below table.

Table 8.1: Summary of Groundwater Exceedances

Contaminant	DWS (µg/l)	Maximum Concentration (µg/l)	Location of Maximum Concentration	No. of Exceedances	Media
Arsenic	10	39	WS101 (2.30m)	2	Soil/Leachate/ Groundwater
Nickel	20	51	WS104	1	Groundwater

The Site is not within a groundwater SPZ and is therefore not considered to be sensitive to contamination.

There is one groundwater abstraction within 679m of the Site, used for non-evaporating cooling purpose usage.

The Site is underlain by Glacial Till which is designated as a Secondary undifferentiated Aquifer and is therefore not considered to be sensitive to contamination.

8.2 Surface Water Assessment

The laboratory analysis reported elevated concentrations of metals exceeding the EQS in two soil leachate samples collected. The exceedances are summarised in the below table.

Table 8.2: Summary of Groundwater Exceedances

Contaminant	EQS (µg/l)	Maximum Concentration (µg/l)	Location of Maximum Concentration	No. of Exceedances	Media
Copper	1	21	WS101 (2.30m)	2	Soil/Leachate
Lead	1.2	1.5	WS101 (2.30m)	1	Soil/Leachate
Nickel	4	8.4	WS101 (2.30m)	1	Soil/Leachate
Zinc	10.9	84	WS101 (2.30m)	1	Soil/Leachate

The nearest surface water feature (Ashton Canal) is 58m to the south of the Site. The Site is underlain by low permeability strata and groundwater is considered unlikely to be in hydraulic connection with surface waters.

8.3 Discussion

Exceedances of arsenic above the DWS protective of groundwater were detected in a leachate sample derived from soils and groundwater samples. Nickel concentrations also exceeded the DWS at WS104. The Site is underlain by Glacial Till which is designated as a Secondary undifferentiated Aquifer and is therefore not considered to be sensitive to slightly elevated levels of contamination. There is one groundwater abstraction within 679m of the Site, used for non-evaporating cooling purpose usage. The Site is not within a groundwater SPZ. The leachate analysis and groundwater analysis did not identify significant sources of contamination at the Site.

Exceedances of some metal compounds above the EQS protective of surface water were detected in leachate samples derived from soils and groundwater samples. The nearest surface water feature (Ashton Canal) is 58m to the south of the Site. The Site is underlain by low permeability strata and groundwater is considered unlikely to be in hydraulic connection with surface waters.

While, theoretically, leaching could occur at the Site, with runoff entering the Ashton Canal, it is noted that no significant sources of contamination have been identified and the development will limit the amount of leaching which could occur due to the presence of hardstanding.

Based on the results of the investigation and assessment there is not considered to be a significant risk to groundwater or controlled waters receptors.

9.0 Ground Gas and Organic Vapour Risk Assessment

A preliminary ground gas risk assessment has been undertaken in accordance with British Standard BS 8485:2015+A1:2019 to assess the impact of permanent ground gases upon the proposed development.

The dataset is considered to be representative and comprehensive.

9.1 Ground Gas Assessment

Field monitoring for permanent ground gases was performed at five monitoring well locations on four occasions on the 7th, 13th and 27th June 2023 as well as the 4th of July 2023. The maximum concentrations are summarised in the table below and the complete monitoring data are provided within Annex D.

Table 9.1: Summary of Gas Monitoring Results

Location	Maximum Methane Concentration (%v/v)	Maximum Carbon Dioxide Concentration (%v/v)	Minimum Oxygen Concentration (%v/v)	Maximum Flow Rate (l/hr)
WS101	0	4.4	16.8	0.1
WS104	0.1	8.8	10.7	0.1
WS106	0.1	4.4	17.4	0.6
WS108	0	3.4	20.9	0.3
BH102	0.2	2.1	19.6	0.6

Methane was detected at low concentrations within BH102, WS104 and WS106. During the four monitoring visits methane was detected three times with a maximum concentration of 0.2%.

Carbon dioxide was detected in all monitoring wells with concentrations ranging from 2.1% to 8.8%. The only location where carbon dioxide levels exceeded 5% was WS104. The levels at WS104 decreased during each monitoring visit, decreasing from 8.8% to 6.7% over the monitoring period.

Minimum oxygen concentrations ranged from 20.9% to 10.7%. The lowest values recorded were in WS104, where elevated levels of carbon dioxide were identified. Depleted oxygen concentrations were generally confined to the location of WS104.

Limited flow was detected at WS101 and WS104, over the course of the four rounds of monitoring. Slightly higher flow rates were recorded at WS106 (0.6l/hr), WS108 (0.3l/hr) and BH102 (0.6l/hr).

Barometric pressure ranged between 1005 – 1013 mbar for the four monitoring rounds and monitoring visits were undertaken during periods of rising and falling atmospheric pressure.

TRC has assessed the permanent ground gas concentrations in accordance with current guidance (BS8485:2015). Based on the results, a gas screening value (GSV) of 0.0528 l/hr was calculated for methane and carbon dioxide, which would classify the Site as Characteristic Situation 1 (very low risk). However, due to the carbon dioxide concentrations exceeding 5% in WS104, the guidance documents state that consideration should be given to increasing the risk classification to Characteristic Situation 2 (low risk).

Based on the results, it is considered that ground gas protection may be required for future proposed developments.

9.2 Organic Vapour from Soil Assessment

For hydrocarbons and other VOCs the LQM S4ULs are considered to be protective of human health from indoor inhalation of organic vapour. Based on the results presented in section 7, there were no exceedances of volatile contaminants.

Field monitoring detected low PID readings in all of the monitoring wells. The highest concentration was identified within WS106 (9.0ppm).

No evidence of elevated levels of VOC were identified during the exploratory works. VOCs were suspected to be present at three locations (BH101, BH102 and WS101), therefore soil samples obtained from these locations were screened for VOCs. The testing and analysis did not identify any VOCs at these locations, above the laboratories limit of detection. PID readings were taken during the investigation and no significantly elevated readings were recorded.

Organic vapour protection measures are not considered to be required.

9.3 Discussion

Based on the results of this preliminary assessment, the GSV calculated for the Site characterises the Site as Characteristic Situation 1 (very low risk) for ground gas; however, due to the presence of carbon dioxide above 5% during some of the monitoring visits, consideration should be given to increasing the risk classification to Characteristic Situation 2 (low risk).

Based on this preliminary assessment, it is considered that ground gas protection may be required the future proposed developments. Further monitoring could potentially be undertaken to determine whether the ground gas classification at the Site could be downgraded.

10.0 Contaminated Land Risk Assessment

The methodology of this risk assessment uses the source-pathway-receptor pollutant linkage to provide a qualitative appraisal of environmental risks and potential liabilities associated with soil and groundwater contamination at the Site. The conceptual site model (CSM) has been prepared considering the proposed end use as light industrial/commercial use.

10.1 Sources of Contamination

The ground investigation performed at the Site by TRC identified the following sources of contamination:

- Asbestos fibres in soil in Made Ground in WS105, WS108, BH101 and BH102
- Concentrations of arsenic in excess of EQS in soil leachate in WS101
- Concentrations of metals in excess of DWS in soil leachate in WS101 and BH101
- Carbon dioxide ground gas in Made Ground in WS104
- Organic vapour in soil.

10.2 Pathways

Based on the information presented in this report the following potentially active pathways have been identified. Consider both construction phase and operational phase.

- Dermal contact, ingestion and inhalation pathways
- Inhalation of soil dust or respirable fibres of asbestos
- Contact with buried services
- Migration of ground gas/organic vapour and ingress into buildings

10.3 Receptors

Based on the information presented in this report the following receptors have been identified.

- Future site users could come into contact with ground gas/organic vapour in indoor air
- Neighbouring site users could come into contact with soil dust during construction works
- Construction and maintenance workers could be exposed to contamination during groundworks and future maintenance works
- Construction materials could come into contact with contamination in the ground

10.4 Revised Conceptual Site Model

The following CSM has been prepared to take into consideration the findings from the intrusive investigation.

Table 10.1: Revised Conceptual Site Model

Source	Pathway	Receptor	Risk
Asbestos in Made Ground in four locations, WS105, WS108, BH101 and BH102	Dermal contact, ingestion and inhalation pathways	Future site users	Low The proposed development will be covered by buildings or hardstanding which will act as a physical barrier between the contamination and future site users.
		Neighbouring site users	Low to Moderate Neighbouring site users/residents could be exposed to contaminated soil dust and/or respirable fibres of asbestos, particularly during the construction phase. Mitigation

Source	Pathway	Receptor	Risk
			measures could include construction site management solutions such as dust control.
		Construction and maintenance workers	Moderate to High Any works which may disturb asbestos must be undertaken in accordance with the Control of Asbestos Regulations (CAR) 2012 and a Plan of Work will be required to manage risks from asbestos.
	Contact with buried services	Buried services	Low Proposed development to consider risk of residual contamination and incorporate protective measures as appropriate. This may include clean service corridors and / or use of chemically resistant pipework.
Soil Leachates of heavy metals in WS101 and BH101 in Mage Ground (WS101 – arsenic for EQS) (WS101 – copper, lead, nickel and zinc) (BH101 – copper)	Leaching of contaminants and vertical migration into groundwater	Secondary (Undifferentiated) Aquifer	Low to Moderate The Made Ground is directly underlain by >15m of Glacial Till which is designated as Secondary (Undifferentiated) Aquifer and is not considered to be sensitive to contamination.
Carbon dioxide concentrations above 5% in WS104.	Migration of ground gases/organic vapour within granular strata and ingress into buildings / confined spaces	Future site users	Low to Moderate The Site is classified as Characteristic Situation Level 2 (Low Risk). Ground gas protection measures will be required to be installed in new buildings.
		Construction workers	Low Pathway to be managed through good construction practices and mitigation of risks when working in confined spaces.

11.0 Summary and Conclusions

11.1 Findings

The 0.9-hectare Site is 'L' shaped and is located to the east of Crabtree Lane. During the time of the ground investigation, the Site was vacated and until recently the Site was occupied by a printworks. The buildings on Site comprised a relatively modern steel framed warehouse at the south of the site and four older, brick-built warehouse buildings to the north, all of which are adjoining. A separate building that appeared to be made from corrugated tin is present at the southeast corner of the site.

The ground conditions comprised Made Ground with thicknesses of between 2.0m and 4.2m across the Site. Superficial deposits comprising interbedded granular and cohesive Till. The base of the Till was not confirmed during the investigation and was encountered to a maximum depth of 15.45m bgl.

A total of 21 No. soil samples were collected for environmental analysis during the investigation works. Minor Concentrations of TPH, PAHs and heavy metals were detected in soil samples (both Made Ground and natural soils). None of the concentrations exceeded the GACs for the proposed commercial end use. Four samples was found to contain asbestos fibres (Amosite, Crocidolite and Chrysotile type), gravimetric quantification analysis indicates that the concentration of asbestos in soil ranged between <0.001 to 8.330%.

One asphalt sample was collected from the pavement and when analysed had exceedances of six PAHs when screened against the commercial GAC, which could potentially classify the material as hazardous. Whilst this is based only on one sample, if asphalt type material is to be removed from Site as part of the redevelopment, it is recommended that further testing is undertaken to confirm the waste classification.

During the TRC investigation, groundwater was recorded in three of the five monitoring wells. Monitoring wells ranged in depth from 0.98m to 3.10m bgl. No free phase oils or hydrocarbons odours were identified. Groundwater samples were taken from BH102, WS101 and WS104. The laboratory analysis on groundwater samples reported elevated concentrations against EQS Criteria and DWS Criteria for some heavy metals. The exceedances are considered to be relatively minor and do not pose a significant risk to controlled waters and underlying aquifers.

Soil Leachate samples were taken to test for any leachable contamination. The laboratory analysis on soil leachate samples reported elevated concentrations against EQS Criteria and DWS Criteria for arsenic, copper, lead, nickel and zinc. The exceedances are considered to be relatively minor and do not pose a significant risk to underlying aquifers.

Ground gas monitoring was carried out at the Site on four occasions. A GSV of 0.0528 l/hr was calculated for methane and carbon dioxide, classifying the Site as Characteristic Situation 1 (very low risk); but since concentration of carbon dioxide was detected above 5% in one location the Site classification rises to Characteristic Situation 2 (low risk) and it is considered that ground gas protection may be required for future proposed developments.

11.2 Summary of Geotechnical Assessment

The primary purpose of this assessment is to identify geotechnical risk, allow design development and inform cost estimates. This report does not constitute a detailed geotechnical design report for the proposed development.

The previous reports and current ground investigation have identified a number of potential geotechnical hazards at the Site which relate to the proposed development; these are Made Ground to 4.20m depth, local soft clays/loose sands and settlement prone soils to depths of at least 10m bgl, the variable nature of Till deposits, the medium volume change potential of cohesive Till, soil desiccation near vegetated areas, shallow groundwater level, ground aggressive to buried concrete, and running sand phenomena. These potential geotechnical hazards are discussed in detail along with mitigation measures in Section 6 of this report.

It is proposed to develop the Site with three industrial/commercial warehouses with associated parking and loading space.

It is likely that the most cost-effective solution will comprise shallow foundations on treated ground to at least 5m bgl. The final bearing capacity of the treated ground for shallow foundations to be adopted will be depended on the method and details of the ground improvement utilized at the Site. Following successful ground improvement, shallow pad or strip foundations should be possible subject to confirmation by a specialist contractor. Details for foundations and ground improvement options are discussed in Sections 6.3 and 6.4.

Ground bearing slabs on previously ground improved/treated Made Ground/Till to a suitable specification could be adopted. Details are provided in Section 6.5 of this report.

Recommendations about proposed excavations, proposed pavements, and classification for buried concrete design are given in Sections 6.6 to 6.8.

11.3 Summary of Contaminated Land Risk Assessment

11.3.1 Soil

There were no exceedances of the GAC in soils for the proposed commercial end use and there is not considered to be a potential risk to human health receptors.

Asbestos was identified within four samples of Made Ground (WS105, WS108, BH101 and BH102). Asbestos identification and quantification were undertaken on these samples and two samples (WS105 and BH101) detected loose asbestos fibres (<0.001% and <0.001%) and the other two samples (WS108 and BH102) identified asbestos fibrous debris (0.031% and 8.330%). The asbestos identified in the samples tested is considered to pose a low risk to future site users as the Site will be predominantly covered in buildings or hardstanding. However, asbestos in soil is considered as a risk to future construction workers if not adequately addressed. Any works which may disturb asbestos must be undertaken in accordance with the Control of Asbestos Regulations (CAR) 2012 and a Plan of Work will be required to manage risks from asbestos.

One asphalt sample was collected from the pavement and when analysed had exceedances of six PAHs when screened against the commercial GAC, which could potentially classify the material as hazardous. Whilst this is based only on one sample, if asphalt type material is to be removed from Site as part of the redevelopment, it is recommended that further testing is undertaken to confirm the waste classification.

11.3.2 Groundwater and Soil Leachate

There were elevated concentrations of heavy metals which exceed the EQS and DWS within the soil leachate samples analysed.

Exceedances of arsenic above the DWS protective of groundwater were detected in both a leachate sample and two groundwater samples. Nickel concentrations also exceeded the DWS in one sample. The Site is underlain by Glacial Till which is designated as Secondary undifferentiated Aquifer deposits and is therefore not considered to be sensitive to slightly elevated levels of contamination. The bedrock geology is also considered to be of low sensitivity. There is one groundwater abstraction within 679m of the Site, used for non-evaporating cooling purpose usage. The Site is not within a groundwater source protection zone. The leachate analysis and groundwater analysis did not identify significant sources of contamination.

Exceedances of some metal compounds above the EQS protective of surface water were detected in leachate samples and groundwater samples. The nearest surface water feature (Ashton Canal) is 58m to the south of the Site. The Site is underlain by low permeability strata and groundwater is considered unlikely to be in hydraulic connection with surface waters.

Based on the results of the investigation and assessment there is not considered to be a significant risk to groundwater or controlled waters receptors.

11.3.3 Ground Gas and Organic Vapour

Based on the results of this assessment the Site would be classified as Characteristic Situation 2 and basic ground gas protection measures would be required for the proposed development. Further monitoring could potentially be undertaken to determine whether the ground gas classification at the Site could be downgraded.

Organic vapour protection measures are not considered to be required as no volatile organic compounds were identified during soil sampling.

11.3.4 Remediation and Mitigation Measures

Based on the results of the generic risk assessments undertaken remediation the following mitigation measures are recommended:

- Ground gas protection measures; and,
- Installation of buried services in corridors of clean soil (where coincident with asbestos contaminated soils or deep made ground)

Any works which have the potential to disturb asbestos must be undertaken in accordance with CAR 2012 and a Plan of Work will be required. An asbestos in soils management plan should be prepared to further assess risks associated with the asbestos in soils identified. Further delineation work could be undertaken prior to the construction phase, to quantify the risk (from ACM) at the location of BH102, inform the asbestos in soils management plan and any necessary mitigation measures.

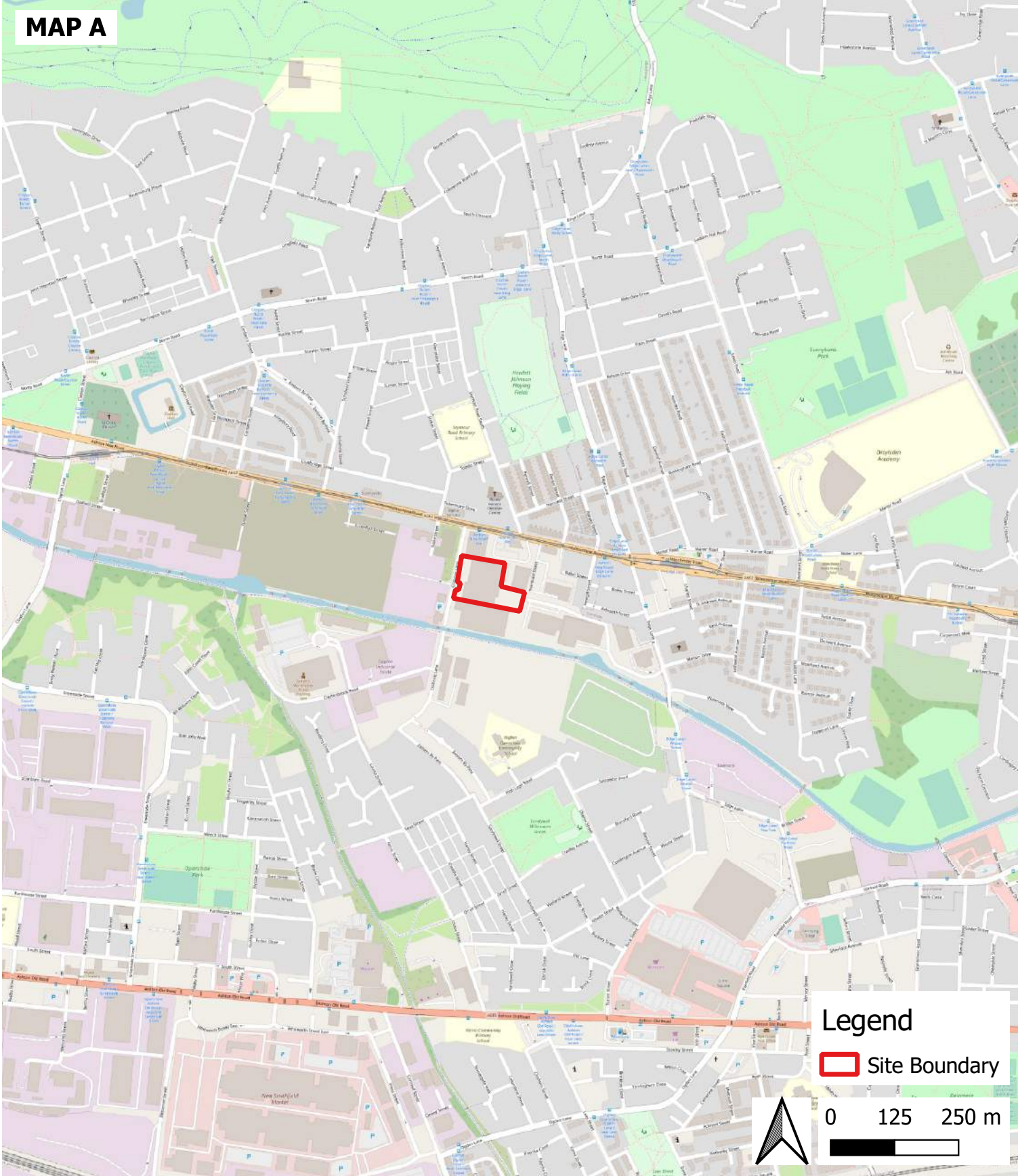
The selection of appropriate water supply pipework should be confirmed by the local water supply company. It will be necessary to undertake a pipe work selection risk assessment, to satisfy the local water authority.

A remediation strategy and verification plan is likely to be required by the local planning authority.

Materials destined for off-site disposal to landfill may require further assessment in accordance with WM3 'Guidance on the classification and assessment of waste' (1st edition version 1.2 GB 2021) to determine their waste classification.

If materials are to be re-used on site or imported from another development site, a materials management plan may be required in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice in order to demonstrate that the material is not a waste.

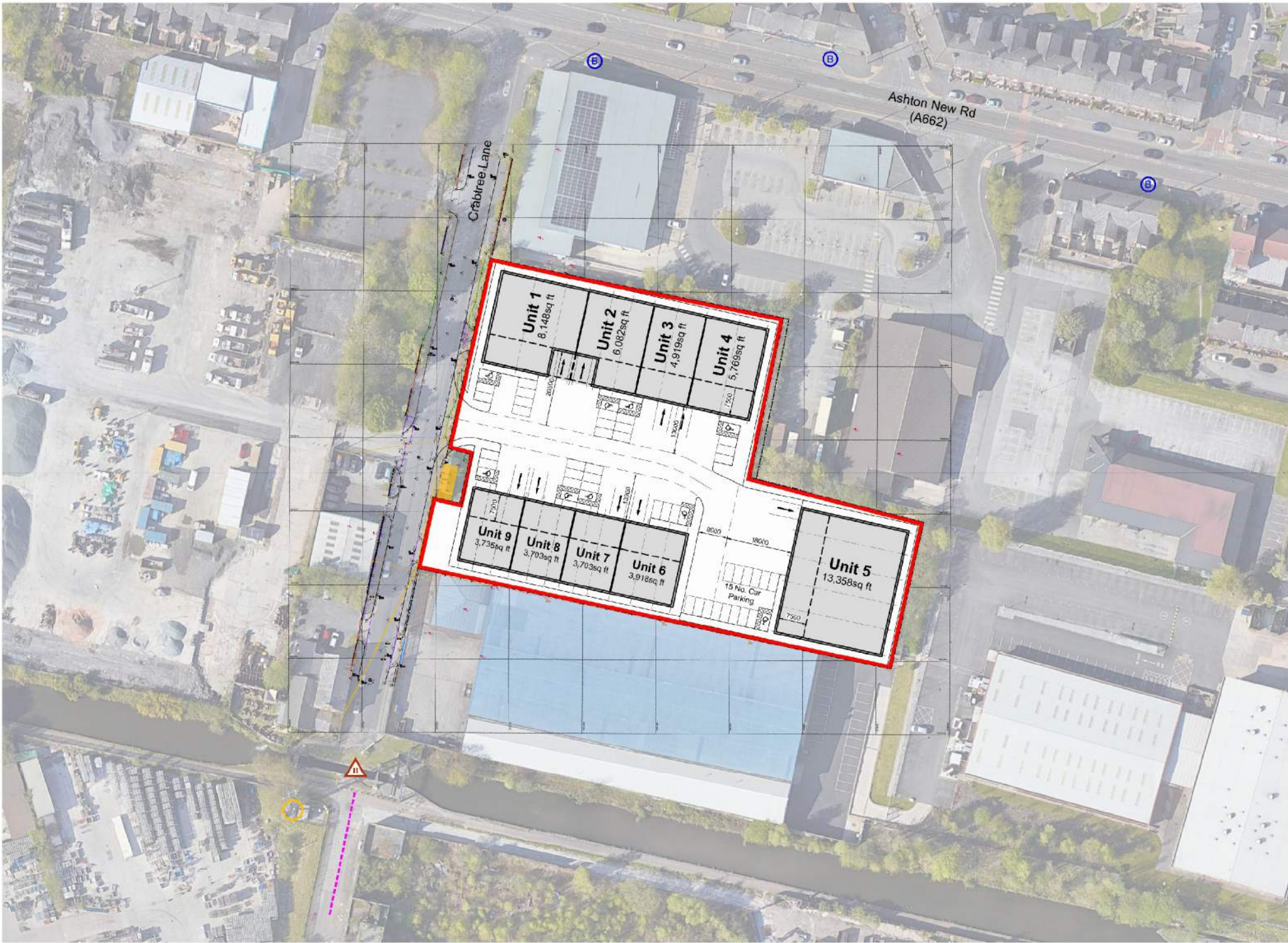
Annex A: Figures



NOTES	COPYRIGHT NOTES				REVISIONS	 Arkwright House Manchester M3 2LF		TITLE						
	Google imagery June 2018 © OpenStreetMap contributors- data is available under the Open Database License. Cartography licensed as CC BY-SA.							SITE LOCATION PLAN						
					TRC PROJECT NO.		SCALE							
					546629		MAP A - 1:10,000 @ A3 MAP B - 1:750 @ A3							
					P01	FIRST ISSUE				CHANCERYGATE		PURPOSE OF ISSUE		STATUS
						Initials	NJ	NJ	12/05/23			SUITABLE FOR INFORMATION		
REV.	REVISION NOTES/COMMENTS				PROJECT CRABTREE LANE, MANCHESTER		DRAWING NO		REVISION					
	Initials						FIGURE 01			PO1				



NOTES	COPYRIGHT NOTES Google imagery June 2018				REVISIONS				 Arkwright House Manchester M3 2LF		TITLE EXPLORATORY HOLE LOCATION PLAN AS DRILLED				
											TRC PROJECT NO. 546629		SCALE 1:500 @ A3		
					P01		FIRST ISSUE				CHANCERYGATE		PURPOSE OF ISSUE		STATUS
													SUITABLE FOR INFORMATION		
									REV.		REVISION NOTES/COMMENTS				PROJECT CRABTREE LANE, MANCHESTER



Dimensions are in millimeters, unless stated otherwise.
Drawing of this drawing is not permitted.
It is the responsibility of the user to ensure that the drawing is used in accordance with the intended purpose.
All drawings and specifications should be read in conjunction with the drawing.

Site Boundary
2.29 acres (0.92 ha)

Schedule of Accommodation				
	GFA	GFA	Mezz	Mezz
UNIT 1				
Warehouse	537	5,740	562	5,295
GF Processed Loading	41	441	45	494
Mezz	179	1,917	185	2,113
Total	757	8,140	822	8,859
UNIT 2				
Warehouse	350	4,168	418	4,478
GF Processed Loading	41	441	45	494
Mezz	156	1,642	164	1,759
Total	547	6,251	627	6,731
UNIT 3				
Warehouse	350	4,168	418	4,478
Mezz	107	1,132	115	1,238
Total	457	5,300	533	5,716
UNIT 4				
Warehouse	411	4,424	443	4,759
Mezz	25	265	30	319
Total	436	4,689	473	5,078
UNIT 5				
Warehouse	580	6,012	1,050	11,200
Mezz	255	2,745	280	3,014
Total	1,241	13,318	1,330	14,314
UNIT 6				
Warehouse	327	3,510	358	3,853
Mezz	128	1,358	140	1,507
Total	455	4,868	498	5,360
UNIT 7				
Warehouse	259	2,815	287	3,089
Mezz	103	1,104	112	1,209
Total	372	4,014	399	4,298
UNIT 8				
Warehouse	259	2,815	287	3,089
Mezz	103	1,104	112	1,209
Total	372	4,014	399	4,298
UNIT 9				
Warehouse	271	2,917	297	3,197
Mezz	154	1,616	175	1,896
Total	425	4,533	472	5,093
GRAND TOTAL	5,129	55,917	5,832	63,642

PO1	Initial Issue	JC	JC	22.05.23
rev	amendments	by	date	date
Former Walkers Site, Crab Tree Lane, Manchester				
Site Layout Option 5				
Informational Content LOD		LOD 100		

Chancerygate

umc architects

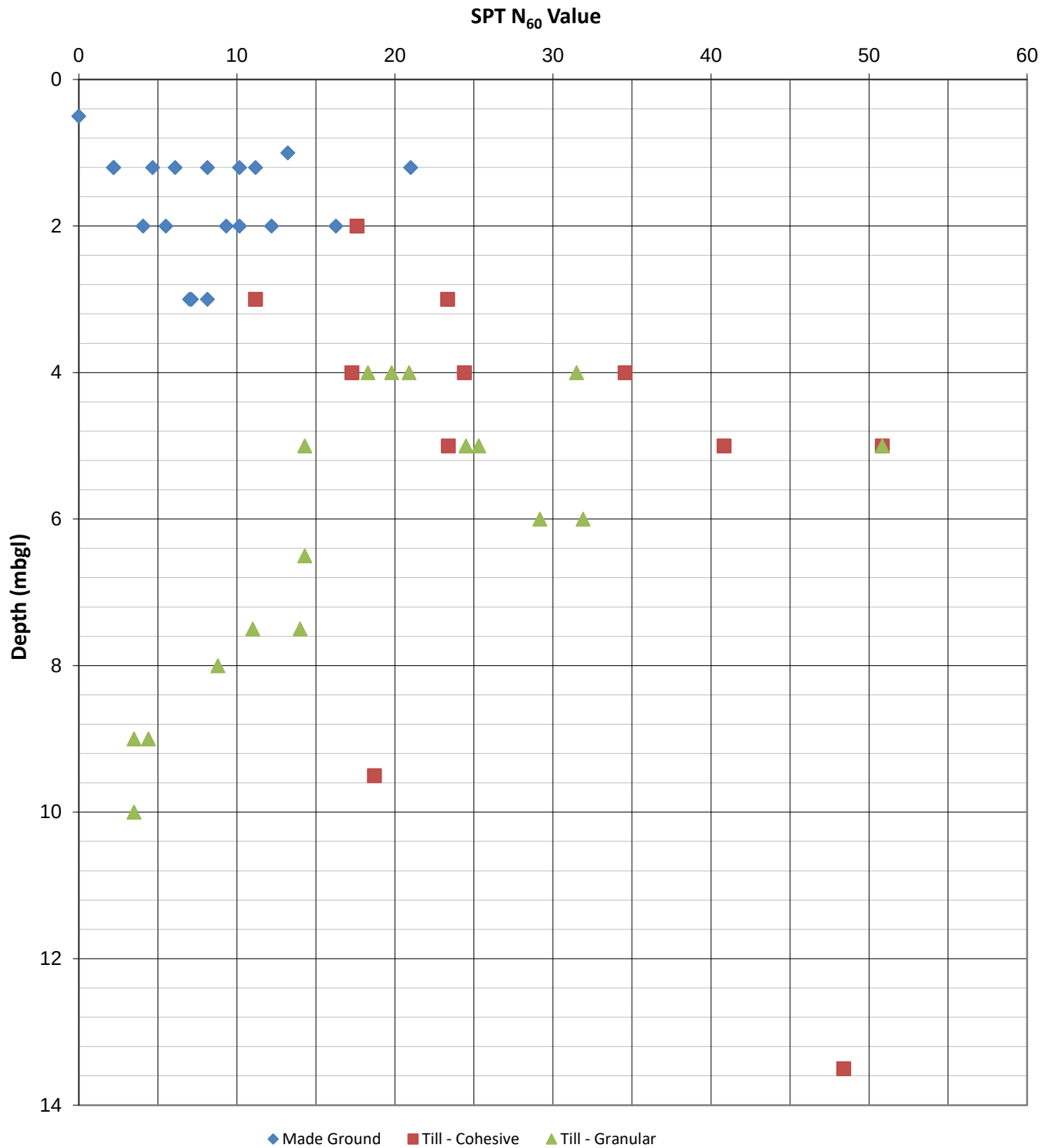
Business Review: Chancerygate, Newbury, Berkshire, UK, 2023. 27th
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Drawn (Checked):	WJC : JC	1 - Preparation & Issue
Date:	22/05/2023	
Scale:	1:500	A1
UMC Project Number:	23166	
Document Reference:	23166 - UMC - XXXX - SI - CR - A	0036
		0036

NOTES	COPYRIGHT NOTES		REVISIONS				Arkwright House Manchester M3 2LF		TITLE	
	Google imagery June 2018								PROPOSED DEVELOPMENT PLAN	
			TRC PROJECT NO.	SCALE						
			546629	1:1000 @ A3						
			P02	FIRST ISSUE			CLIENT		PURPOSE OF ISSUE	STATUS
Initials	TS	TS	07/07/23	SUITABLE FOR INFORMATION						
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	Initials				CRABTREE LANE, MANCHESTER		FIGURE 2	PO1		

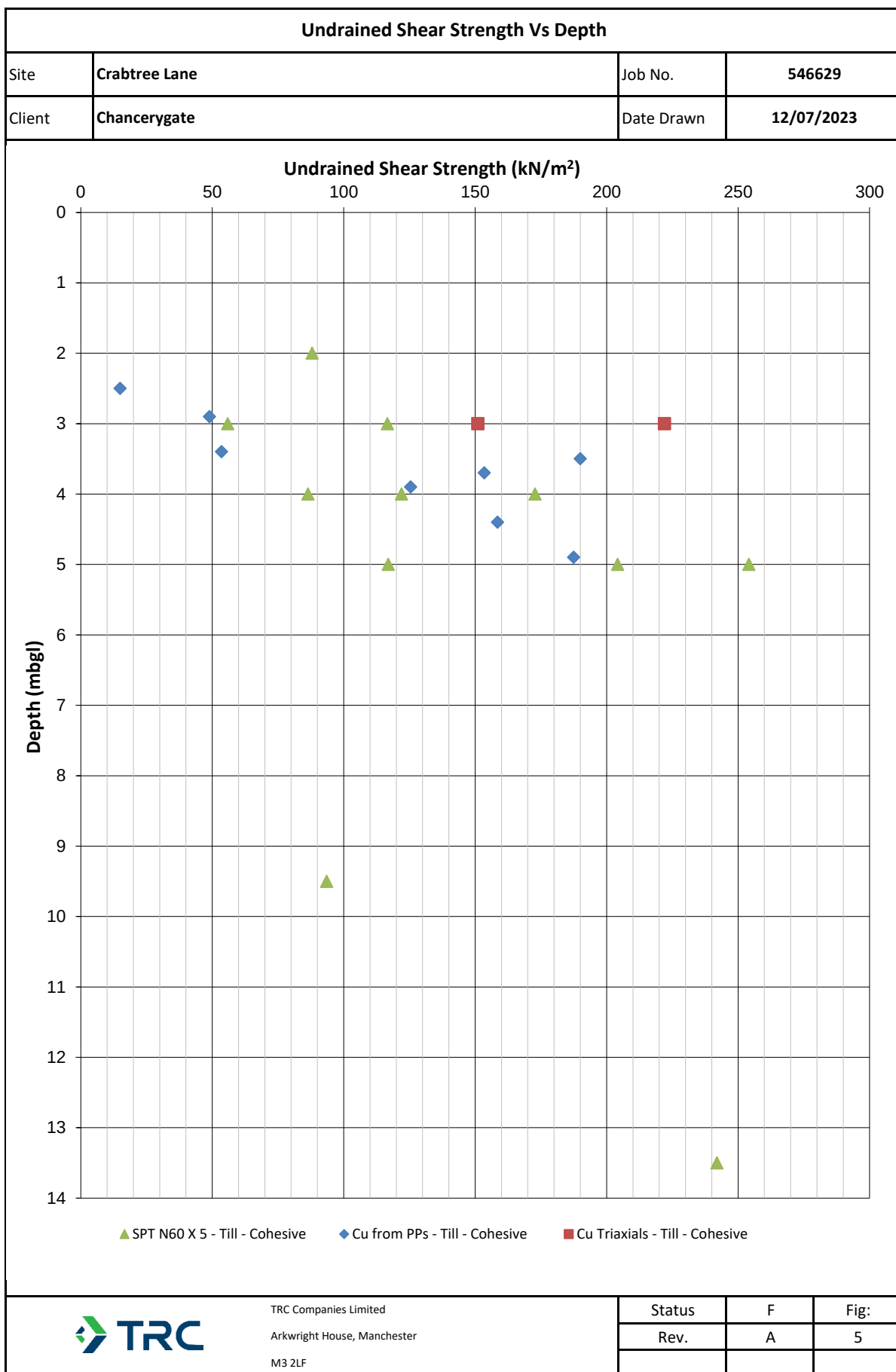
SPT N₆₀ Value Vs Depth

Client	Chancerygate	Job No.	546629
Site	Crabtree Lane	Date Drawn	07/07/2023



TRC Companies Limited
 Arkwright House, Manchester
 M3 2LF

Status	F	Fig:
Rev.	A	4



Annex B: Site Photographs

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 1	Date				
Description: WS101					

Client Name:		Site Location:		Project No.:	
Photo No. 2	Date				
Description: WS101 1 – 4.45m					

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 3	Date				
Description: WS102					

Client Name:		Site Location:		Project No.:	
Photo No. 4	Date				
Description: WS103					

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 5	Date				
Description: WS104					

Client Name:		Site Location:		Project No.:	
Photo No. 6	Date				
Description: WS104 1 – 5.45m					

Photographic Log

Client Name:		Site Location:	Project No.:
Photo No. 7	Date		
Description: WS105			

Client Name:		Site Location:	Project No.:
Photo No. 8	Date		
Description: WS105			

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 9	Date				
Description: WS106					

Client Name:		Site Location:		Project No.:	
Photo No. 10	Date				
Description: WS106					

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 11	Date				
Description: WS107					

Client Name:		Site Location:		Project No.:	
Photo No. 12	Date				
Description: WS107					

Photographic Log

Client Name:		Site Location:		Project No.:	
Photo No. 13	Date				
Description: WS108					

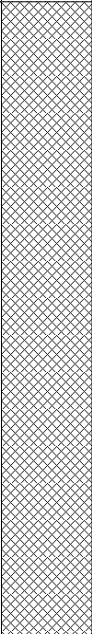
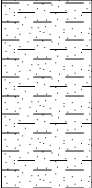
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Photo No. 14	Date				
Description: WS108					

Annex C: Exploratory Hole Logs



Percussion Drilling Log

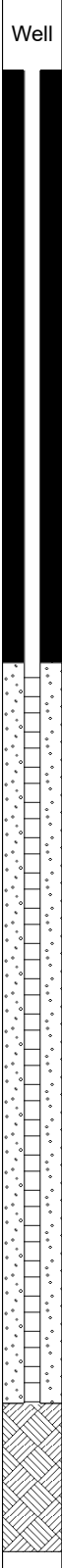
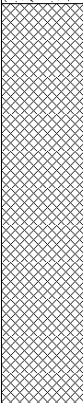
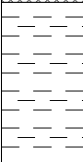
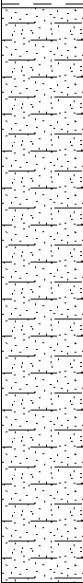
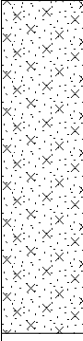
Project Name: Crabtree Lane, Manchester		Client: Chancerygate		Date: 26/05/2023	
Location: M11 4GU		Contractor: TRC Companies Ltd		Co-ords: E388795.00 N398207.00	
Project No. : 546629		Crew Name: GSS		Drilling Equipment: Cable Percussive	
Borehole Number BH101	Hole Type CP	Level	Logged By Martin Dorfling	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50 0.60	B ES					MADE GROUND: Black slightly clayey very gravelly SAND. Sand is fine to coarse, gravel is angular, fine to coarse grained. Gravel consists of clinker and brick. Medium cobble content of brick.	1
		1.20 1.20	B SPT	N=4 (1,2/1,1,1,1)					2
		2.50	ES						
		3.00 3.00	D SPT	N=6 (4,5/3,1,1,1)					3
		4.00 4.00	D SPT	N=32 (3,4/5,7,10,10)	4.20			Very stiff brown sandy CLAY. Sand is fine to medium grained. (TILL)	4
		5.00 5.00	D SPT	N=35 (6,6/7,8,10,10)	5.45				5
								End of Borehole at 5.450m	6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
5.45	150										

Remarks Borehole terminated at 5.45m bgl due to time constraints. Groundwater encountered at 3.2m bgl. Hand pit excavated to 1.2m bgl.										
---	--	--	--	--	--	--	--	--	--	---



Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.25			MADE GROUND: Concrete		
	0.50 0.60 0.80	B PID ES						MADE GROUND: Black very gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of clinker and brick. Medium cobble content of brick.	1	
	1.20 1.20	B SPT	N=18 (6,6/6,4,4,4)							
	2.00	SPT	N=6 (3,3/2,2,1,1)			2				
	3.00 3.00 3.00	B D SPT	N=20 (3,3/4,5,6,5)		2.90			Very stiff brown CLAY. (TILL)	3	
	4.00 4.00 4.20	B SPT ES	N=27 (4,4/5,7,7,8)		4.00			Medium dense brown clayey slightly gravelly SAND. Sand is fine to coarse grained. Gravel is well rounded, fine to medium of flint. (TILL)	4	
	5.00 5.00	B SPT	N=21 (3,3/4,5,6,6)						5	
	6.00 6.00 6.00	B D SPT	N=25 (3,6/7,6,6,6)						6	
	7.50 7.50 7.50	B D SPT	N=12 (1,1/2,2,3,5)		7.80				7	
	9.00 9.00 9.20	B SPT ES	N=3 (0,1/0,1,1,1)				Medium dense becoming very loose brown silty SAND. Sand is fine to coarse grained. Fine black kerogen grains. (TILL)	8		
	10.00	D			10.00				9	
										10

Remarks	
Borehole terminated at 10.0m bgl due to refusal in very dense gravels.	
No groundwater encountered.	
Hand pit excavated to 1.2m bgl.	
Monitoring well installed to 9.0m bgl.	



[illegible]

Borehole terminated at 15.45m bgl, at planned depth.
Groundwater encountered at 15.0m bgl.
Hand pit excavated to 1.2m bgl.
Monitoring well installed to 15.0m bgl.





Percussion Drilling Log

Project Name: Crabtree Lane, Manchester		Client: Chancerygate		Date: 13/06/2023 - 14/06/2023	
Location: M11 4GU		Contractor: TRC Companies Ltd		Co-ords: E388707.00 N398189.00	
Project No. : 546629.0001		Crew Name: DMW Drilling		Drilling Equipment: Cable Percussion	
Borehole Number BH202	Hole Type CP	Level	Logged By MD	Scale 1:50	Page Number Sheet 2 of 2

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50 10.50	D SPT	N=4 (1,0/1,1,1,1)	10.80			Loose black SAND. Sand is fine to coarse grained. Sand is dark grey from kerogen fragments. (TILL)	11
								Very stiff brown slightly sandy CLAY. Sand is fine grained. (TILL)	
		12.00 12.00	U UT	Ublow=50 Ublow=50			12		
		13.50 13.50	D SPT	N=44 (7,7/7,10,12,15)			13		
							14		
	15.00 15.00	D SPT	N=50 (7,9/50 for 225mm)	15.45					15
								End of Borehole at 15.450m	16
									17
									18
									19
									20

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
15.00	150										

Remarks

Borehole terminated at 15.45m bgl, at planned depth.
Groundwater encountered at 15.0m bgl.
Hand pit excavated to 1.2m bgl.
Monitoring well installed to 15.0m bgl.





Percussion Drilling Log

Project Name: Crabtree Lane, Manchester		Client: Chancerygate		Date: 12/06/2023	
Location: M11 4GU		Contractor: TRC Companies Ltd		Co-ords: E388716.00 N398250.00	
Project No. : 546629.0001		Crew Name: DMW Drilling		Drilling Equipment: Cable Percussion	
Borehole Number BH203	Hole Type CP	Level	Logged By MD	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			MADE GROUND: Bituminous surfacing.	
		0.50 0.50	B D					MADE GROUND: Black silty very gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of clinker and brick. Medium cobble content of brick.	1
		1.20 1.20	D SPT	N=2 (1,0/1,0,0,1)					
		2.00 2.00 2.00	B D SPT	N=16 (1,2/3,3,4,6)	2.00			Very stiff brown slightly sandy CLAY. Sand is fine to medium grained. (TILL)	2
		2.80 3.00 3.00	PP U UT	346.51 Ublow=25 Ublow=25					3
		4.00 4.00	D SPT	N=19 (4,4/5,5,4,5)	4.00			Medium dense becoming loose brown SAND. Sand is fine to coarse grained. (TILL)	4
		5.00 5.00	B SPT	N=13 (3,3/3,3,4,3)					5
		6.50 6.50	D SPT	N=13 (3,4/3,4,3,3)					6
		8.00 8.00 8.00	B D SPT	N=8 (2,2/2,2,2,2)					7
		9.50 9.50	D SPT	N=17 (3,4/4,4,4,5)	9.40			Very stiff brown slightly sandy CLAY. Sand is fine to medium grained. (TILL)	9
					10.00			End of Borehole at 10.000m	10

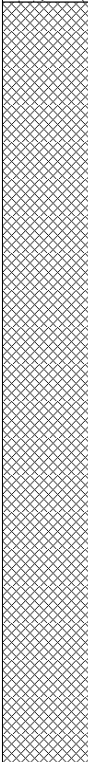
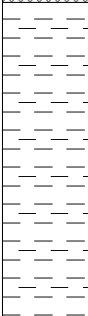
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
10.00	120										

Remarks

Borehole terminated at 10.0m bgl, at planned depth.
No groundwater encountered.
Hand pit excavated to 1.2m bgl.





Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.18			MADE GROUND: Concrete.	
		0.50	ES	N=8 (2,2/2,2,2,2)		MADE GROUND: Black slightly silty gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to medium grained. Gravel consists of clinker. Hydrocarbon odour at 2.2m bgl. Medium cobble content of brick.			
		0.70	PID						
		0.90	D						
		1.20	SPT						
		1.50	PID						
		1.80	D	N=10 (2,3/3,2,2,3)					
		2.00	SPT						
		2.20	PID						
		2.30	ES						
		3.00	SPT				N=13 (4,3/3,3,3,4)		
		3.20						Very stiff brown CLAY. (TILL)	
		3.40	ES	379.19					
		3.50	PP						
		3.80	D						
	4.00	SPT	N=24 (3,3/4,6,6,8)						
				4.45			End of Borehole at 4.450m		

Remarks	
Borehole terminated at 4.45m bgl due to collapsing soil.	
No groundwater encountered.	
Hand pit excavated to 1.2m bgl.	
Monitoring well installed to 2.7m bgl.	

[illegible]

Remarks Borehole terminated at 1.4m bgl due to refusal on cobbles in Made Ground. No groundwater encountered. Hand pit excavated to 1.2m bgl.	
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[illegible][illegible]

Borehole terminated at 1.2m bgl due to drilling time restraints.
No groundwater encountered.
Hand pit excavated to 1.2m bgl.





Windowless Sample Log

Project Name: Crabtree Lane, Manchester		Client: Chancerygate		Date: 24/05/2023	
Location: M11 4GU		Contractor: TRC Companies Ltd		Co-ords: E388762.00 N398228.00	
Project No. : 546629		Crew Name: GSS		Drilling Equipment: Window(less) Sampling Rig	
Borehole Number WS104	Hole Type WS	Level	Logged By Martin Dorfling	Scale 1:30	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.17			MADE GROUND: Concrete.	
		0.50 0.60	PID ES	PID=0.00				MADE GROUND: Black slightly silty very gravelly SAND. Sand is fine to medium, Gravel is angular, fine to coarse grained. Gravel consists of glass, slag, clinker and claystone.	1
		0.80	D						
		1.20	SPT	N=11 (2,3/3,3,3,2)					
		1.80 1.80 2.00	D PID SPT	N=16 (3,3/3,3,5,5)					2
					2.20				
		3.00	SPT	N=8 (1,1/2,2,2,2,2)				MADE GROUND: Black slightly sandy GRAVEL. Sand is fine to coarse, Gravel is angular, medium to coarse grained. Gravel consists of Type 1 fill.	3
					3.50				
		3.70	PP	307.28				Dense becoming very dense brown CLAY. (TILL)	
		3.90 4.00	ES SPT	N=34 (5,4/5,7,9,13)					4
		4.20	D						
		4.40	PP	317.09					
		5.00	SPT	N=50 (25 for 75mm/50 for 200mm)	5.00				5
								End of Borehole at 5.200m	
									6

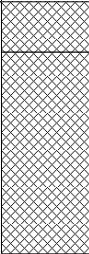
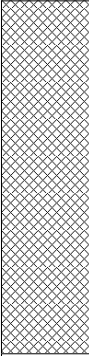
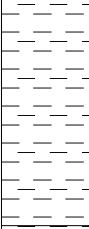
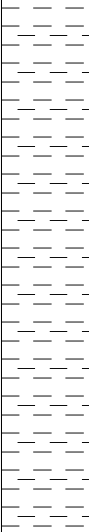
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
5.00	80										

Remarks

Borehole terminated at 5.2m bgl due to refusal in very stiff clay.
No groundwater encountered.
Hand pit excavated to 1.2m bgl.
Monitoring well installed to 2.6m bgl.
Refusal on SPT.

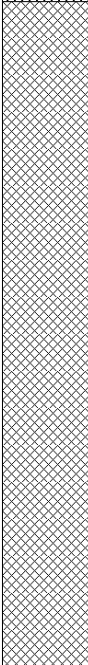
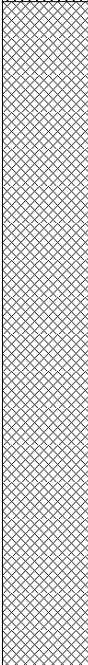
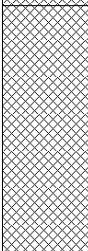
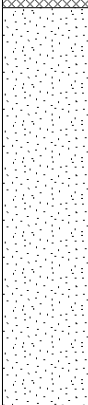




Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			MADE GROUND: Grey very sandy GRAVEL. Sand is fine to medium, Gravel is sub-rounded, medium to coarse grained. Gravel consists of mudstone. Grass covered.	
		0.50	D					MADE GROUND: Black very gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of clinker, slag, asphalt and brick. Medium cobble content of brick.	
		0.70	PID						
		1.00	ES		1.00			MADE GROUND: Black slightly clayey gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to medium grained. Gravel consists of clinker, slag and asphalt.	1
		1.20	SPT	N=10 (1,1/2,2,3,3)					
		1.70	D						
		1.80	PID						
		2.00	SPT	N=6 (1,0/1,0,2,3)					2
		2.50	PP	29.42	2.40		Stiff grey CLAY.		
		2.70	D						
		2.90	PP	98.07					
		3.00	SPT	N=11 (1,1/2,3,3,3)					3
		3.40	PP	107.87	3.30		Very stiff brown CLAY. (TILL)		
		3.90	ES	251.71					4
		3.90	PP						
		4.00	SPT	N=17 (2,2/4,4,4,5)					
		4.20	D						
	4.90	PP	375.93			End of Borehole at 5.450m	5		
	5.00	SPT	N=23 (5,5/5,5,5,8)						
	5.20	D							
				5.45				6	

Remarks	
Borehole terminated at 5.45m bgl at targeted depth.	
No groundwater encountered.	
Hand pit excavated to 1.2m bgl.	



Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.15			MADE GROUND: Bituminous surfacing.		
		0.50	PID					MADE GROUND: Grey very sandy GRAVEL. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of brick. Medium cobble content of brick.		
		0.70	ES							
		1.20	SPT	N=6 (3,3/2,1,1,2)						
		1.50	D							
		2.00	SPT	N=4 (1,1/1,1,1,1)						
					2.80			MADE GROUND: Black sandy slightly gravelly CLAY. Sand is fine to coarse grained. Gravel is angular, fine to coarse grained. Gravel consists of brick.		
		3.00	SPT	N=7 (1,1/1,2,2,2)						
		3.30	D							
		3.50	ES							
					3.80			Medium dense to very dense black SAND. Sand is medium to coarse grained. (TILL)		
		4.00	SPT	N=18 (1,1/4,4,5,5)						
	4.90	D								
	5.00	SPT	N=50 (3,14/50 for 160mm)							
				5.40				End of Borehole at 5.400m		

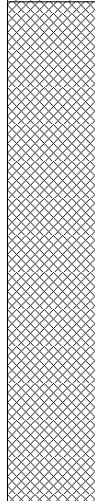
Remarks Borehole terminated at 5.4m bgl due to refusal in very dense gravels. No groundwater encountered. Hand pit excavated to 1.2m bgl. Monitoring well installed to 2.0m bgl. Hole collapsed at 2.0m bgl. Refusal on SPT.	
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Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15		MADE GROUND: Concrete.	
		0.40 0.50 0.50	PID ES SPT	N=0 (1,0/0,0,0,0)			MADE GROUND: Black slightly silty very gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of clinker, slag, brick and concrete. Burned wooden materials at 2.8m to 3.0m. Presence of voids between the bricks at 1m bgl. The hole collapsed at 2m.	
		0.90 1.00	D SPT	N=13 (1,0/0,3,4,6)				1 –
		2.00	SPT	N=12 (8,8/3,3,3,3)				2 –
		2.90	ES		3.00			3 –
							End of Borehole at 3.000m	4 –
								5 –
								6 –

Remarks	
Borehole terminated at 3.0m bgl due to hole collapsing.	
No groundwater encountered.	
Hand pit excavated to 1.2m bgl.	



Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.25			MADE GROUND: Concrete.	
		0.80	D					MADE GROUND: Black very gravelly SAND. Sand is fine to coarse, Gravel is angular, fine to coarse grained. Gravel consists of clinker, glass, brick and concrete. Medium cobble content of brick.	1
		1.20	SPT	N=8 (2,2/2,2,2,2)					
		1.60	ES						
		2.00	SPT	N=50 (10,14/50 for 115mm)		2			
					2.25			End of Borehole at 2.250m	3
								4	
									5
									6

Remarks Borehole terminated at 2.25m bgl due to refusal in MADE GROUND. No groundwater encountered. Hand pit excavated to 1.2m bgl. Monitoring well installed to 1.8m bgl. Refusal on SPT.	
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Composite Materials and Lithology

Legend	Code	Description	Legend	Code	Description
	101	Topsoil		730	Boulders
	102	Made Ground or Fill		801	Mudstone
	103	Asphalt		802	Siltstone
	104	Concrete		803	Sandstone
	201	Clay		804	Limestone or Dolomite
	301	Silt		805	Chalk
	401	Sand		806	Coal
	501	Gravel		807	Breccia
	601	Peat		808	Conglomerate
	701	Cobbles		809	Fine Grained Igneous

Backfill

Legend	Code	Description	Legend	Code	Description
	901	Sand Filter		902 908	Gravel Filter Ballast
	903	Bentonite		904	Grout
	905	Arisings		906 912	Concrete Paving Slab
	907	Asphalt		999	Void

NB: Composite soil types are represented by combined legends. Each type will have its own code within the AGS data.

In-Situ Testing

Prefix	Type	Comments
SPT(S)	Standard Penetration Test	Uncorrected test results at relevant start depth. Hammer ID and Energy Ratio reported on log and in relevant AGS fields
SPT(C)	(S) Split Spoon (C) Solid Cone	
HV	Hand Vane Test	Undrained Shear Strength reported in kPa.
PP	Hand Penetrometer Test	Unconfined Compressive Strength reported in kPa
PID	On-Site Volatile Headspace Testing by Photo Ionization Detector	Screening reported as ppmv. Headspace testing undertaken as per contract documents
PPM	In-Situ Permeability Test	Permeability (k) reported in m/s. Please refer to individual test sheets for data and methodology

Sampling

Prefix	Type	Comments
D	Small Disturbed Sample	Nominally 1kg
B	Bulk Disturbed Sample	Nominally 5kg
LB	Large Bulk Disturbed Sample	25kg to 60kg depending on material type, for compaction related tests
U	Undisturbed sample - thick wall driven tube	For CP, nominally 100mm diameter, 450mm length. For WS, nominally 38mm diameter, 100mm length. Blows to drive tube and recovery found in remarks
UT	Undisturbed Sample – Thin wall driven tube	Nominally 100mm diameter, 450mm length. Blows to drive tube and recovery found in remarks
P	Pushed piston sample	Nominally 100mm diameter, 1000mm length. Recovery found in remarks
C	Core sample	-
AMAL	Amalgamated Sample	Details of samples used noted in remarks as well as relevant AGS field
W	Water sample	Not for environmental testing purposes
ES	Environmental sample	Multiple containers used where appropriate
EW	Environmental water sample	Multiple containers used where appropriate

Installations

Legend	Description
	Piezometer Plain Pipe
	Piezometer Slotted Pipe

Water Observations

Legend	Description
	Water strike
	Standing water level after specified time

Details are provided on each log through the Water Strike Table

Rotary Boreholes:

T.C.R. - Total Core Recovery %
 S.C.R. - Solid Core Recovery %
 R.Q.D. - Rock Quality Designation %
 F.I. - Fracture Index

All soil and rock descriptions in general accordance with BS5930, BS EN ISO 14688 and BS EN ISO 14689

Annex D: Field Data



Notes:	Ambient Co
	CH4
	CO2
	O2
	H2S
	CO

QA Checklist:	
Weather conditions logged for previous 24 hrs	
Gas monitor calibrated	
All filters in place	
Flow reading stable and zeroed	



Date: _____

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Depth to water (m)	Depth to base (m)	Comn (all readings from note datum height)
WS4	.07.23/11:	997	Peak:997	Peak:0	30	0	0	6.6	11.6	0	0	0	1		2.37	2.69	
			Steady:997	Steady:0	60	0	0	6.6	11.5	0	0	0	1				
					120	0	0	6.7	11.5	0	0	0	1				
					180	0	0	6.7	11.5	0	0	0	1				
					240	0	0	6.8	11.4	0	0	0	1				
					300	0	0	6.9	11.2	0	0	0	1				
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady: -													
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady:													

Notes:

Previous weather conditions, Atmospheric pressure trend and rate, flooding, soil moisture, water draw in tube, wind direction/strength, condition of monitoring point, missing/open tap, datum level, vegetation stress, odours, bubbles, etc.

[illegible][illegible][illegible]



Project:

Crabtree Lane

Job Number:

546629

Engineer:

NJ

Date:

07.06.23

Weather:

Mild, cloudy

Monitoring Point	Date/ Time	Atmos. Pressure	Well Pressure	Flow Rate (l/h)	Time (s)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppb)	Depth to Water (m)	Depth to base (m)	Comments (all readings from ground level different)
WS106	.06.23/10:30	1013	Peak:1014	Peak:0.3	30	0	0	3.8	16.5	0	0	0	1		dry	2.02	
			60	0	0	3.8	16.4	0	0	0	1						
			120	0	0	3.8	16.3	0	0	0	1						
			Steady:1012	Steady:-0.3	180	0	0	3.8	16.3	0	0	0	1				
			240	0	0	3.8	16.3	0	0	0	1						
			300	0	0	3.8	16.4	0	0	0	1						
			BH102	.06.23/10:30	1013	Peak:1015	Peak:0.6	30	0	0	1.4	19	0				
60	0	0				1.4	18.9	0	0	0	1						
120	0	0				1.5	18.7	0	0	0	1						
Steady:1015	Steady:0.6	180				0	0	1.7	18.2	0	0	0	1				
240	0	0				2	17.8	0	0	0	1						
300	0	0				2	17.7	0	0	0	1						
WS108	.06.23/10:30	1012				Peak:1012	Peak:0	30	0	0	3.1	15.3	0	0	0	1	
			60	0	0	3.2	15.1	0	0	0	1						
			120	0	0	3.2	14.9	0	0	0	1						
			Steady:1012	Steady:0	180	0	0	3.3	14.9	0	0	0	1				
			240	0	0	3.3	14.8	0	0	0	1						
			300	0	0	3.4	14.8	0	0	0	1						
			WS101	.06.23/11:30	1012	Peak:1012	Peak:0	30	0	0	4	15.7	0	0	0	1	
60	0	0				4.1	15.6	0	0	0	1						
120	0	0				4.1	15.4	0	0	0	1						
Steady:1012	Steady:0	180				0	0	4.2	15.3	0	0	0	1				
240	0	0				4.2	15.2	0	0	0	1						
300	0	0				4.3	15.1	0	0	0	1						

Notes:

Ambient Conditions

CH4

CO2

O2

H2S

CO

Previous weather conditions, Atmospheric pressure trend and rate, flooding, soil moisture, water draw in tube, wind direction/strength, condition of monitoring point, missing/open tap, datum level, vegetation stress, odours, bubbles, etc.

QA Checklist:

Weather conditions logged for previous 24 hrs

Gas monitor calibrated

All filters in place

Flow reading stable and zeroed

Instrument Details:

Serial No.

Hyder/other ref.

Landfill Gas Analyser

PID

Dip meter/ interface probe



Project: _____

Date: _____

Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Depth to water (m)	Depth to base (m)	Comn (all readings from note datum height)
WS104	.06.23/11:	1012	Peak:1012	Peak:0	30	0	0	7.7	11	0	0	0	1				
			Steady:1012	Steady:0	60	0	0	7.8	10.8	0	0	0	1				
					120	0	0	7.9	10.7	0	0	0	1				
					180	0	0	8	10.5	0	0	0	1				
					240	0	0	8.5	9.6	0	0	0	1				
					300	0	0	8.8	9	0	0	0	1				
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady: -													
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady:													

Notes:

Previous weather conditions, Atmospheric pressure trend and rate, flooding, soil moisture, water draw in tube, wind direction/strength, condition of monitoring point, missing/open tap, datum level, vegetation stress, odours, bubbles, etc.

[illegible][illegible][illegible]



Notes:	Ambient Co
	CH4
	CO2
	O2
	H2S
	CO

Previous weather conditions, Atmospheric pressure trend and rate, flooding, soil moisture, water draw in tube, wind direction/strength, condition of monitoring point, missing/open tap, datum level, vegetation stress, odours, bubbles, etc.

Instrument Details:	Serial No.	Hyder/other ref.
Landfill Gas Analyser		
PID		
Dip meter/ interface probe		



Monitoring Point Reference	Date/ Time	Atmos. Pressure (mbar)	Well Pressure (Pa)	Flow Rate (l/h)	Time (sec)	CH4 (% v/v)	LEL (%)	CO2 (% v/v)	O2 (% v/v)	H2S (ppm)	CO (ppm)	Hex. (%)	PID cf	VOC (ppm)	Depth to water (m)	Depth to base (m)	Comn (all readings from note datum height)
WS4	.06.23/12:	1006	Peak:1006	Peak:0	30	0	0	7.1	10.7	0	0	0	1				
			Steady:1006	Steady:0	60	0	0	7.2	10.5	0	0	0	1				
					120	0	0	7.2	10.6	0	0	0	1				
					180	0	0	7.2	10.5	0	0	0	1				
					240	0	0	7.2	10.5	0	0	0	1				
					300	0	0	7.3	10.3	0	0	0	1				
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady: -													
			Peak:	Peak:													
			Steady:	Steady:													
			Peak:	Peak:													
			Steady:	Steady:													

Notes:

Previous weather conditions, Atmospheric pressure trend and rate, flooding, soil moisture, water draw in tube, wind direction/strength, condition of monitoring point, missing/open tap, datum level, vegetation stress, odours, bubbles, etc.

ments

m ground level,
ght if different)

ments

m ground level,
ght if different)

Page ____ of ____

Annex E: Laboratory Chemical Data



4041

Nyemh Johnson
TRC Companies Ltd
20 Red Lion Street, London
WC1R 4PQ

e: nyemh.johnson@trccompanies.com



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

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 23-41897

Project / Site name:	Crabtree Lane	Samples received on:	28/06/2023
Your job number:	546629	Samples instructed on/ Analysis started on:	28/06/2023
Your order number:	546629	Analysis completed by:	04/07/2023
Report Issue Number:	1	Report issued on:	04/07/2023
Samples Analysed:	3 water samples		


Signed:

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

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

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

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

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

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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Analytical Report Number: 23-41897

Project / Site name: Crabtree Lane

Your Order No: 546629

Lab Sample Number				2729619	2729620	2729621
Sample Reference				BH2	WS1	WS4
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied	None Supplied
Date Sampled				27/06/2023	27/06/2023	27/06/2023
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)				Units	Limit of detection	Accreditation Status

General Inorganics

pH (L005B)	pH Units	N/A	ISO 17025	7.2	6.4	6
------------	----------	-----	-----------	-----	-----	---

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	ISO 17025	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01

Total PAH

Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16
-------------------	------	------	-----------	--------	--------	--------

Heavy Metals / Metalloids

Boron (dissolved)	µg/l	10	ISO 17025	160	100	200
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0	< 5.0
Chromium (III)	µg/l	5	NONE	< 5.0	< 5.0	< 5.0

Arsenic (dissolved)	µg/l	0.15	ISO 17025	21.6	10.5	0.87
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02	< 0.02	0.07
Chromium (dissolved)	µg/l	0.2	ISO 17025	< 0.2	0.3	0.4
Copper (dissolved)	µg/l	0.5	ISO 17025	< 0.5	3	4.3
Lead (dissolved)	µg/l	0.2	ISO 17025	0.6	0.4	< 0.2
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	4	6	51
Selenium (dissolved)	µg/l	0.6	ISO 17025	0.6	< 0.6	< 0.6
Zinc (dissolved)	µg/l	0.5	ISO 17025	2.8	120	630

Monoaromatics & Oxygenates

Benzene	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0
Toluene	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0
Ethylbenzene	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0
p & m-xylene	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0
o-xylene	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	3	ISO 17025	< 3.0	< 3.0	< 3.0



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Analytical Report Number: 23-41897

Project / Site name: Crabtree Lane

Your Order No: 546629

Lab Sample Number				2729619	2729620	2729621
Sample Reference				BH2	WS1	WS4
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied	None Supplied
Date Sampled				27/06/2023	27/06/2023	27/06/2023
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status			

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >C5 - C6## _{HS_1D_AL}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8## _{HS_1D_AL}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10## _{HS_1D_AL}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12 _{EH_1D_AL_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16 _{EH_1D_AL_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21 _{EH_1D_AL_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35 _{EH_1D_AL_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35) _{HS+EH_1D_AL_MS}	µg/l	10	NONE	< 10	< 10	< 10

TPH-CWG - Aromatic >C5 - C7 _{HS_1D_AR}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8 _{HS_1D_AR}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10 _{HS_1D_AR}	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12 _{EH_1D_AR_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16 _{EH_1D_AR_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C16 - C21 _{EH_1D_AR_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35 _{EH_1D_AR_MS}	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35) _{HS+EH_1D_AR_MS}	µg/l	10	NONE	< 10	< 10	< 10

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

Analytical Report Number : 23-41897

Project / Site name: Crabtree Lane

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
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Boron in water	Determination of boron in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM	L039-PL	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Cr (III) in water	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE

Analytical Report Number : 23-41897

Project / Site name: Crabtree Lane

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
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In house method.	L099-PL	W	ISO 17025

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.

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

- Quality control parameter has a high recovery (outside of limit); however the associated result is below the reporting limit, other checks applied prior to reporting the data have been accepted. The result should be considered as being deviating and may be compromised.

Annex F: Screened Data

TRC Environmental - Chemical Assessment Record																									
Contract Engineer	Jonathon Sander																								
Project/Site Name	Crabtree Lane, Manchester																								
Project Number	546629.0000.0000																								

Sample Reference		WS101	WS101	WS101	WS102	WS103	WS104	WS104	WS104	WS105	WS105	WS106	WS106	WS106	WS107	WS107	WS108	BH101	BH101	BH102	BH102	BH102	BH202	AR sample
Depth		0.5	2.3	3.4	0.5	1	0.6	3.9	1	0.6	3.9	0.7	3.5	5.2	0.5	2.9	1.8	0.6	2.5	0.8	4.2	9.2	0.5	0
Date Sampler		24/05/2023	24/05/2023	24/05/2023	24/05/2023	24/05/2023	24/05/2023	24/05/2023	24/05/2023	25/05/2023	25/05/2023	25/05/2023	25/05/2023	25/05/2023	24/05/2023	24/05/2023	25/05/2023	26/05/2023	26/05/2023	24/05/2023	24/05/2023	25/05/2023	13/06/2024	13/06/2024
Time Taken																								

Analytical Parameter (Soil Analysis)	Units	S4UL																						
Stone Content	%		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20	<0.1	<0.1	0
Moisture Content	%		11	35	14	14	11	8.6	15	11	15	12	19	16	9.7	34	17	7.9	18	8.7	4	17	8.7	0

Speciated PAHs																									
Naphthalene	mg/kg	180	3.6	0.56	<0.05	0.85	0.6	3	<0.05	2.8	<0.05	0.85	0.7	<0.05	0.38	<0.05	<0.05	0.96	0.21	US\$§	0.19	<0.05	4	1500	
Acenaphthylene	mg/kg	83000	0.23	<0.05	<0.05	0.47	0.12	0.09	<0.05	1.2	<0.05	0.08	<0.05	<0.05	0.11	<0.05	<0.05	0.09	0.91	US\$§	<0.05	<0.05	0.6	<1.5	
Acenaphthene	mg/kg	84000	0.69	<0.05	<0.05	0.82	0.7	0.49	<0.05	5.9	<0.05	0.42	0.79	0.16	1.8	0.07	<0.05	0.82	0.26	US\$§	0.19	<0.05	3.3	890	
Fluorene	mg/kg	63000	0.66	<0.05	<0.05	0.86	0.54	0.36	<0.05	5.2	<0.05	0.37	0.65	0.09	0.84	0.1	<0.05	0.57	0.33	US\$§	0.11	<0.05	3	740	
Phenanthrene	mg/kg	22000	7.7	0.46	0.28	9	7.9	5.1	0.43	58	0.1	2.9	0.79	0.12	12	0.67	0.33	7.1	3.8	US\$§	2	<0.05	25	2500	
Anthracene	mg/kg	520000	2.4	<0.05	0.05	1.7	1.8	0.82	0.09	15	<0.05	0.6	0.55	<0.05	3.4	0.22	0.09	1.7	1.1	US\$§	0.39	<0.05	5.4	1200	
Fluoranthene	mg/kg	23000	8.6	0.77	0.35	12	14	5.5	0.6	82	0.12	4.8	1.5	0.16	25	0.97	0.82	11	8.5	US\$§	3.5	<0.05	25	2000	
Pyrene	mg/kg	54000	8.7	0.76	0.35	11	14	5.3	0.54	74	0.12	4.7	1.2	0.14	21	0.86	0.75	9.6	9.3	US\$§	3.7	<0.05	23	2100	
Benzo(a)anthracene	mg/kg	170	4	0.47	0.18	5.6	6.4	2.5	0.29	36	0.07	2.5	0.61	0.08	11	0.46	0.56	4.4	3.9	US\$§	1.6	<0.05	9.4	1300	
Chrysene	mg/kg	350	4	0.5	0.17	5.5	6	2.5	0.28	37	0.06	2.5	0.56	0.07	11	0.37	0.6	4.9	4.5	US\$§	1.8	<0.05	9	1200	
Benzo(b)fluoranthene	mg/kg	44	4	0.55	0.17	6.2	7.3	2.4	0.31	33	0.09	3.7	0.7	0.09	13	0.49	0.61	5.3	6	US\$§	2	<0.05	9.2	980	
Benzo(k)fluoranthene	mg/kg	1200	1.7	0.21	0.05	2.3	2.5	0.97	0.08	20	<0.05	1.1	0.27	<0.05	5.2	0.22	0.22	2.2	2.6	US\$§	0.81	<0.05	3.9	490	
Benzo(a)pyrene	mg/kg	36	3.5	0.47	0.12	5.1	6	1.9	0.22	33	0.06	3	0.61	0.07	10	0.44	0.41	4.2	5.2	US\$§	1.5	<0.05	7.9	990	
Indeno(1,2,3-cd)pyrene	mg/kg	500	2	0.28	0.08	2.7	3.6	1.1	0.14	16	0.05	2.2	0.42	<0.05	5.4	0.24	0.27	2.2	3.2	US\$§	0.75	<0.05	4.4	490	
Dibenz(a,h)anthracene	mg/kg	3.5	0.58	0.07	<0.05	0.75	0.98	0.34	<0.05	3.3	<0.05	0.56	0.12	<0.05	1.3	<0.05	<0.05	0.62	0.82	US\$§	<0.05	<0.05	1.2	130	
Benzo(ghi)perylene	mg/kg	3900	2.2	0.31	0.08	2.9	3.8	1.2	0.16	20	0.05	2.2	0.46	<0.05	6.3	0.25	0.32	2.8	3.7	US\$§	0.96	<0.05	5.1	550	
Total PAH																									
Speciated Total EPA-16 PAHs	mg/kg	N/A	54.5	5.41	1.88	67.4	75.7	33.4	3.14	442	<0.83	32.5	9.9	0.98	127	5.36	4.98	58	54.3	US\$§	19.3	<0.83	139	17000	

Heavy Metals / Metalloids																									
Arsenic	mg/kg	640	140	300	28	190	450	33	15	49	9.8	15	17	2.5	22	69	33	11	23	US\$§	5.2	6.7	32	0	
Boron	mg/kg	240000	1.7	2.2	0.7	3.3	0.4	1.1	0.2	0.7	0.4	0.7	0.9	0.3	0.7	4.7	<0.2	1	3.1	US\$§	<0.2	<0.2	0.7	0	
Cadmium	mg/kg	190	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.6	1.2	1.3	US\$§	<0.2	<0.2	<0.2	0
Chromium (hexavalent)	mg/kg	33	US**	US**	US**	US**	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	US\$§	<1.8	<1.8	12	0	
Chromium (III)	mg/kg	8600	4000	34	31	38	120	30	32	160	29	20	16	4.7	18	92	110	26	38	US\$§	7.2	3.1	1700	0	
Copper	mg/kg	68000	120	72	36	200	140	90	50	170	26	73	47	9.4	89	170	97	100	98	US\$§	15	6.6	1300	0	
Lead	mg/kg	2300	1300	340	25	120	610	160	23	320	34	1300	110	8.1	210	1400	290	260	170	US\$§	12	10	100	0	
Elemental Mercury	mg/kg	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Inorganic Mercury	mg/kg	1100	1	8.3	<0.3	1.6	<0.3	<0.3	<0.3	1.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.9	<0.3	<0.3	2.2	US\$§	<0.3	<0.3	<0.3	0	
Methyl Mercury	mg/kg	320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nickel	mg/kg	980	33	8.8	35	15	26	38	42	33	43	20	17	5.4	24	17	27	12	31	US\$§	9.6	3.5	53	0	
Selenium	mg/kg	12000	<1.0	15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	US\$§	<1.0	<1.0	<1.0	0	
Zinc	mg/kg	730000	470	300	70	75	52	390	110	1100	69	82	49	19	260	250	380	300	440	US\$§	31	16	180	0	

Monocaromatics																									
Benzene	µg/kg	27000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Toluene	µg/kg	5.6E+07	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Ethylbenzene	µg/kg	5700000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
p & m-xylene	µg/kg	5900000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
o-xylene	µg/kg	6600000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	7600000	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0

Petroleum Hydrocarbons																									
TPH-CWG - Aliphatic >EC5 - EC8	mg/kg	3200	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0
TPH-CWG - Aliphatic >EC8 - EC8	mg/kg	7800	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	2000	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	9700	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	59000	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	1600000	<0.0	150	<0.0	<0.0	<0.0	8.6	<0.0	12	<0.0	<0.0	<0.0	<0.0	<0.0	41	10	<0.0	320	US\$5	<0.0	<0.0	<0.0	<0.0	0
TPH-CWG - Aliphatic >EC21 - EC25	mg/kg	1600000	14	53	<0.0	<0.0	45	38	<0.0	65	<0.0	<0.0	17	12	15	410	34	51	3700	US\$5	53	<0.0	<0.0	<0.0	0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	N/A	17	240	<0.0	11	50	51	<0.0	62	<0.0	<0.0	22	14	21	450	46	60	4100	US\$5	57	<0.0	<0.0	<0.0	0

1,1,1-Trichloroethane	µg/kg	660000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2-Dichloroethane	µg/kg	670	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,1-Dichloropropene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Trans-1,2-dichloroethene	µg/kg	22000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Benzene	µg/kg	27000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Tetrachloromethane	µg/kg	2900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2-Dichloropropane	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Trichloroethene	µg/kg	1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Dibromomethane	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Bromodichloromethane	µg/kg	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Cis-1,3-dichloropropene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Trans-1,3-dichloropropene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Toluene	µg/kg	5.6E+07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,1,2-Trichloroethane	µg/kg	94000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,3-Dichloropropane	µg/kg	3300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Dibromochloromethane	µg/kg	270000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Tetrachloroethene	µg/kg	19000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2-Dibromoethane	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Chlorobenzene	µg/kg	56000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,1,1,2-Tetrachloroethane	µg/kg	110000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Ethylbenzene	µg/kg	5700000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
p & m-Xylene	µg/kg	5900000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Styrene	µg/kg	3300000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0###	0	0
Tribromomethane	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
o-Xylene	µg/kg	6600000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,1,2,2-Tetrachloroethane	µg/kg	270000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Isopropylbenzene	µg/kg	1400000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Bromobenzene	µg/kg	97000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
n-Propylbenzene	µg/kg	4100000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
2-Chlorotoluene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
4-Chlorotoluene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,3,5-Trimethylbenzene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
tert-Butylbenzene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2,4-Trimethylbenzene	µg/kg	42000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
sec-Butylbenzene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,3-Dichlorobenzene	µg/kg	30000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
p-Isopropyltoluene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2-Dichlorobenzene	µg/kg	2000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,4-Dichlorobenzene	µg/kg	4400000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Butylbenzene	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2-Dibromo-3-chloropropane	µg/kg	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2,4-Trichlorobenzene	µg/kg	220000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
Hexachlorobutadiene	µg/kg	31000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0
1,2,3-Trichlorobenzene	µg/kg	102000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<5.0	0	0

TRC Companies Ltd - Chemical Assessment Record						
Analytical Report Number:			23-41897			
Project / Site name:			Crabtree Lane			
Your Order No:			546629			
Lab Sample Number				2729619	2729620	2729621
Sample Reference				BH102	WS101	WS104
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied	None Supplied
Date Sampled				27/06/2023	27/06/2023	27/06/2023
Time Taken				None Supplied	None Supplied	None Supplied
Analytical Parameter (Water Analysis)	Units	Limit of detection	Accreditation Status			
General Inorganics						
pH	pH Units	N/A	ISO 17025	7.2	6.4	6
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025			
Total Cyanide	µg/l	10	ISO 17025			
Complex Cyanide	µg/l	10	ISO 17025			
Free Cyanide	µg/l	10	ISO 17025			
Thiocyanate as SCN	µg/l	200	ISO 17025			
Sulphate as SO ₄	µg/l	45	ISO 17025			
Sulphate as SO ₄	mg/l	0.045	ISO 17025			
Total Sulphur	µg/l	15	NONE			
Sulphide	µg/l	5	NONE			
Chloride	mg/l	0.15	ISO 17025			
Ammonium as NH ₄	µg/l	15	ISO 17025			
Dissolved Organic Carbon (DOC)	mg/l	0.1	NONE			
Total Suspended Solids	mg/l	2	ISO 17025			
Phenols by HPLC						
Catechol	µg/l	0.5	NONE			
Resorcinol	µg/l	0.5	NONE			
Ethylphenol & Dimethylphenol	µg/l	0.5	NONE			
Cresols	µg/l	0.5	NONE			
Naphthols	µg/l	0.5	NONE			
Isopropylphenol	µg/l	0.5	NONE			
Phenol	µg/l	0.5	NONE			
Trimethylphenol	µg/l	0.5	NONE			
Total Phenols						
Total Phenols (HPLC)	µg/l	3.5	NONE			
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	ISO 17025	< 0.01	< 0.01	< 0.01
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01
Total PAH						
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16
Heavy Metals / Metalloids						
Arsenic (dissolved)	µg/l	0.15	ISO 17025	21.6	10.5	0.87
Boron (dissolved)	µg/l	10	ISO 17025	160	100	200
Cadmium (dissolved)	µg/l	0.02	ISO 17025	< 0.02	< 0.02	0.07
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0	< 5.0
Chromium (III)	µg/l	1	NONE	< 5.0	< 5.0	< 5.0
Chromium (dissolved)	µg/l	0.2	ISO 17025	< 0.2	0.3	0.4
Copper (dissolved)	µg/l	0.5	ISO 17025	< 0.5	3	4.3
Lead (dissolved)	µg/l	0.2	ISO 17025	0.6	0.4	< 0.2
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05	< 0.05
Nickel (dissolved)	µg/l	0.5	ISO 17025	4	6	51
Selenium (dissolved)	µg/l	0.6	ISO 17025	0.6	< 0.6	< 0.6
Zinc (dissolved)	µg/l	0.5	ISO 17025	2.8	120	630
Monoaromatics & Oxygenates						
Benzene	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
Toluene	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
Ethylbenzene	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
p & m-xylene	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
o-xylene	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 3.0	< 3.0	< 3.0
Petroleum Hydrocarbons						
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10

TRC Companies Ltd - Chemical Assessment Record								
Contract Engineer								
Project/Site Name								
Project Number								
Sample Reference						BH102	WS101	WS104
Depth						None Supplied	None Supplied	None Supplied
Date Sampled						27/06/2023	27/06/2023	27/06/2023
Time Taken						None Supplied	None Supplied	None Supplied
Determinand	Unit	Source	Screening Criteria	Min	Max			
General Inorganics								
pH	Units	N/A	N/A	6.00	7.20	7.2	6.4	6
Electrical Conductivity at 20 °C	µS/cm	N/A	N/A	0	0	0	0	0
Total Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0	0
Complex Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0	0
Free Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0	0
Thiocyanate as SCN	µg/l	N/A	N/A	0.00	0.00	0	0	0
Sulphate as SO ₄	µg/l	N/A	N/A	0	0	0	0	0
Sulphate as SO ₄	mg/l	N/A	N/A	0.00	0.00	0	0	0
Total Sulphur	µg/l	N/A	N/A	0	0	0	0	0
Sulphide	µg/l	N/A	N/A	0.00	0.00	0	0	0
Chloride	mg/l	US EPA	250	0.00	0.00	0	0	0
Ammonium as NH ₄	µg/l	N/A	N/A	0	0	0	0	0
Dissolved Organic Carbon (DOC)	mg/l	N/A	N/A	0.00	0.00	0	0	0
Total Suspended Solids	mg/l	N/A	N/A	0	0	0	0	0
Phenols by HPLC								
Catechol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Resorcinol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Ethylphenol & Dimethylphenol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Cresols	µg/l	N/A	N/A	0.00	0.00	0	0	0
Naphthols	µg/l	N/A	N/A	0.00	0.00	0	0	0
Isopropylphenol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Phenol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Trimethylphenol	µg/l	N/A	N/A	0.00	0.00	0	0	0
Total Phenols								
Total Phenols (HPLC)	µg/l	N/A	N/A	0.00	0.00	0	0	0
Speciated PAHs								
Naphthalene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Acenaphthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Acenaphthylene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Phenanthrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Fluorene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Chrysene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Pyrene (aq)	ug/l	DWI 17	0.01	0.00	0.00	< 0.01	< 0.01	< 0.01
Benzo(a)anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Benzo(k)fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Dibenzo(a,h)anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Benzo(g,h,i)perylene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01	< 0.01
Total EPA-16 PAHs	ug/l	DWI 17	0.1	0.00	0.00	< 0.16	< 0.16	< 0.16
Heavy Metals / Metalloids								
Arsenic (dissolved)	ug/l	WSR 18	10	0.87	21.60	21.6	10.5	0.87
Boron (dissolved)	ug/l	WSR 18	1,000	100.00	200.00	160	100	200
Cadmium (dissolved)	ug/l	WSR 18	5	0.07	0.07	< 0.02	< 0.02	0.07
Chromium (hexavalent)	ug/l	WHO CICAD / US EPA RfD	5.4	0.00	0.00	< 5.0	< 5.0	< 5.0
Chromium (dissolved)	ug/l	WSR 18	50	0.30	0.40	< 0.2	0.3	0.4
Copper (dissolved)	ug/l	WSR 18	2,000	3.00	4.30	< 0.5	3	4.3
Lead (dissolved)	ug/l	WSR 18	10	0.40	0.60	0.6	0.4	< 0.2
Mercury (dissolved)	ug/l	WSR 18	1	0.00	0.00	< 0.05	< 0.05	< 0.05
Nickel (dissolved)	ug/l	WSR 18	20	4.00	51.00	4	6	51
Selenium (dissolved)	ug/l	WSR 18	10	0.60	0.60	0.6	< 0.6	< 0.6
Zinc (dissolved)	ug/l	US EPA	5000	2.80	630.00	2.8	120	630
Monoaromatics								
Benzene	ug/l	PHG 17	10	0.00	0.00	< 3.0	< 3.0	< 3.0
Toluene	ug/l	PHG 17	700	0.00	0.00	< 3.0	< 3.0	< 3.0
Ethylbenzene	ug/l	PHG 17	300	0.00	0.00	< 3.0	< 3.0	< 3.0
p & m-xylene	ug/l	PHG 17	500	0.00	0.00	< 3.0	< 3.0	< 3.0
o-xylene	ug/l	PHG 17	500	0.00	0.00	< 3.0	< 3.0	< 3.0
MTBE	ug/l	N/A	N/A	0.00	0.00	< 3.0	< 3.0	< 3.0
Petroleum Hydrocarbons								
Aliphatic >C5 - C6	ug/l	PHG 17	15000	0.00	0.00	< 1.0	< 1.0	< 1.0
Aliphatic >C6 - C8	ug/l	PHG 17	15000	0.00	0.00	< 1.0	< 1.0	< 1.0
Aliphatic >C8 - C10	ug/l	PHG 17	300	0.00	0.00	< 1.0	< 1.0	< 1.0
Aliphatic >C10 - C12	ug/l	PHG 17	300	0.00	0.00	< 10	< 10	< 10
Aliphatic >C12 - C16	ug/l	PHG 17	300	0.00	0.00	< 10	< 10	< 10
Aliphatic >C16 - C21	ug/l	N/A	N/A	0.00	0.00	< 10	< 10	< 10
Aliphatic >C21 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10	< 10
Aliphatic (C5 - C35)	ug/l	N/A	N/A	0.00	0.00	< 10	< 10	< 10
Petroleum Hydrocarbons								
Aromatic >C5 - C7	ug/l	PHG 17	10	0.00	0.00	< 1.0	< 1.0	< 1.0
Aromatic >C7 - C8	ug/l	PHG 17	700	0.00	0.00	< 1.0	< 1.0	< 1.0
Aromatic >C8 - C10	ug/l	PHG 17	500	0.00	0.00	< 1.0	< 1.0	< 1.0
Aromatic >C10 - C12	ug/l	PHG 17	90	0.00	0.00	< 10	< 10	< 10
Aromatic >C12 - C16	ug/l	PHG 17	90	0.00	0.00	< 10	< 10	< 10
Aromatic >C16 - C21	ug/l	PHG 17	90	0.00	0.00	< 10	< 10	< 10
Aromatic >C21 - C35	ug/l	PHG 17	90	0.00	0.00	< 10	< 10	< 10
Total >C5 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10	< 10

TRC Companies Ltd - Chemical Assessment Record			
Contract Engineer		Jonathon Sander	
Project/Site Name		Crabtree Lane	
Project Number		546629.0000.0000	

Sample Reference	WS101	BH101
Depth	2.30	2.50
Date Sampled	24/05/2023	26/05/2023
Time Taken	0.0	0.0

Determinand	Unit	Source	Screening Criteria	Min	Max		
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General Inorganics

pH	Units	N/A	N/A	5.80	8.00	5.8	8
Electrical Conductivity at 20 °C	µS/cm	N/A	N/A	0	0	-	-
Total Cyanide	µg/l	N/A	N/A	0.00	0.00	-	-
Complex Cyanide	µg/l	N/A	N/A	0.00	0.00	-	-
Free Cyanide	µg/l	N/A	N/A	0.00	0.00	-	-
Thiocyanate as SCN	µg/l	N/A	N/A	0.00	0.00	-	-
Sulphate as SO ₄	µg/l	N/A	N/A	0	0	-	-
Sulphate as SO ₄	mg/l	N/A	N/A	0.00	0.00	-	-
Total Sulphur	µg/l	N/A	N/A	0	0	-	-
Sulphide	µg/l	N/A	N/A	0.00	0.00	-	-
Chloride	mg/l	US EPA	250	0.00	0.00	-	-
Ammonium as NH ₄	µg/l	N/A	N/A	0	0	-	-
Dissolved Organic Carbon (DOC)	mg/l	N/A	N/A	0.00	0.00	-	-
Total Suspended Solids	mg/l	N/A	N/A	0	0	-	-

Phenols by HPLC

Catechol	µg/l	N/A	N/A	0.00	0.00	-	-
Resorcinol	µg/l	N/A	N/A	0.00	0.00	-	-
Ethylphenol & Dimethylphenol	µg/l	N/A	N/A	0.00	0.00	-	-
Cresols	µg/l	N/A	N/A	0.00	0.00	-	-
Naphthols	µg/l	N/A	N/A	0.00	0.00	-	-
Isopropylphenol	µg/l	N/A	N/A	0.00	0.00	-	-
Phenol	µg/l	N/A	N/A	0.00	0.00	-	-
Trimethylphenol	µg/l	N/A	N/A	0.00	0.00	-	-

Total Phenols

Total Phenols (HPLC)	µg/l	N/A	N/A	0.00	0.00	-	-
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Speciated PAHs

Naphthalene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Acenaphthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Acenaphthylene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Phenanthrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Fluorene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Chrysene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Pyrene (aq)	ug/l	DWI 17	0.01	0.00	0.00	< 0.01	< 0.01
Benzo(a)anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Benzo(b)fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Benzo(k)fluoranthene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Benzo(a)pyrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Dibenzo(a,h)anthracene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Benzo(g,h,i)perylene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene (aq)	ug/l	DWI 17	0.1	0.00	0.00	< 0.01	< 0.01
Total EPA-16 PAHs	ug/l	DWI 17	0.1	0.00	0.00	< 0.2	< 0.2

Heavy Metals / Metalloids

Arsenic (dissolved)	ug/l	WSR 18	10	2.20	39.00	39	2.2
Boron (dissolved)	ug/l	WSR 18	1,000	120.00	170.00	120	170
Cadmium (dissolved)	ug/l	WSR 18	5	0.00	0.00	< 0.08	< 0.08
Chromium (hexavalent)	ug/l	CICAD / US EPA	5.4	0.00	0.00	< 5.0	< 5.0
Chromium (dissolved)	ug/l	WSR 18	50	0.00	0.00	0	0
Copper (dissolved)	ug/l	WSR 18	2,000	12.00	21.00	21	12
Lead (dissolved)	ug/l	WSR 18	10	1.50	1.50	1.5	< 1.0
Mercury (dissolved)	ug/l	WSR 18	1	0.00	0.00	< 0.5	< 0.5
Nickel (dissolved)	ug/l	WSR 18	20	2.00	8.40	8.4	2
Selenium (dissolved)	ug/l	WSR 18	10	0.00	0.00	< 4.0	< 4.0
Zinc (dissolved)	ug/l	US EPA	5000	9.70	84.00	84	9.7

Monoaromatics

Benzene	ug/l	PHG 17	10	0.00	0.00	< 3.0	< 3.0
Toluene	ug/l	PHG 17	700	0.00	0.00	< 3.0	< 3.0
Ethylbenzene	ug/l	PHG 17	300	0.00	0.00	< 3.0	< 3.0
p & m-xylene	ug/l	PHG 17	500	0.00	0.00	< 3.0	< 3.0
o-xylene	ug/l	PHG 17	500	0.00	0.00	< 3.0	< 3.0
MTBE	ug/l	N/A	N/A	0.00	0.00	< 10	< 10

Petroleum Hydrocarbons

Aliphatic >C5 - C6	ug/l	PHG 17	15000	0.00	0.00	< 1.0	< 1.0
Aliphatic >C6 - C8	ug/l	PHG 17	15000	0.00	0.00	< 1.0	< 1.0
Aliphatic >C8 - C10	ug/l	PHG 17	300	0.00	0.00	< 1.0	< 1.0
Aliphatic >C10 - C12	ug/l	PHG 17	300	0.00	0.00	< 10	< 10
Aliphatic >C12 - C16	ug/l	PHG 17	300	0.00	0.00	< 10	< 10
Aliphatic >C16 - C21	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aliphatic >C21 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aliphatic (C5 - C35)	ug/l	N/A	N/A	0.00	0.00	< 10	< 10

Petroleum Hydrocarbons

Aromatic >C5 - C7	ug/l	PHG 17	10	0.00	0.00	< 1.0	< 1.0
Aromatic >C7 - C8	ug/l	PHG 17	700	0.00	0.00	< 1.0	< 1.0
Aromatic >C8 - C10	ug/l	PHG 17	500	0.00	0.00	< 1.0	< 1.0
Aromatic >C10 - C12	ug/l	PHG 17	90	0.00	0.00	< 10	< 10
Aromatic >C12 - C16	ug/l	PHG 17	90	0.00	0.00	< 10	< 10
Aromatic >C16 - C21	ug/l	PHG 17	90	0.00	0.00	< 10	< 10
Aromatic >C21 - C35	ug/l	PHG 17	90	0.00	0.00	< 10	< 10
Total >C5 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10

TRC Companies Ltd - Leachate Assessment Record (EQS)	
Contract Engineer	Jonathon Sander
Project/Site Name	Crabtree Lane
Project Number	546629.0000.0000

Sample Reference	WS101	BH101
Depth	2.30	2.50
Date Sampled	24/05/2023	26/05/2023
Time Taken	0.0	0.0

Determinand	Unit	Source	Screening Criteria	Min	Max	
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General Inorganics							
pH	Units	N/A	N/A	5.80	8.00	5.8	8

Speciated PAHs							
Naphthalene (aq)	ug/l	GUK 18	2	<0.01	<0.01	< 0.01	< 0.01
Acenaphthene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Acenaphthylene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Fluoranthene (aq)	ug/l	GUK 18	0.0063	<0.01	<0.01	< 0.01	< 0.01
Anthracene (aq)	ug/l	GUK 18	0.1	<0.01	<0.01	< 0.01	< 0.01
Phenanthrene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Fluorene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Chrysene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Pyrene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Benzo(a)anthracene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Benzo(b)fluoranthene (aq)	ug/l	GUK 18	0.00017	<0.01	<0.01	< 0.01	< 0.01
Benzo(k)fluoranthene (aq)	ug/l	GUK 18	0.00017	<0.01	<0.01	< 0.01	< 0.01
Benzo(a)pyrene (aq)	ug/l	GUK 18	0.00017	<0.01	<0.01	< 0.01	< 0.01
Dibenzo(a,h)anthracene (aq)	ug/l	N/A	N/A	<0.01	<0.01	< 0.01	< 0.01
Benzo(g,h,i)perylene (aq)	ug/l	GUK 18	0.00017	<0.01	<0.01	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene (aq)	ug/l	GUK 18	0.00017	<0.01	<0.01	< 0.01	< 0.01
Total EPA-16 PAHs	ug/l	N/A	N/A	<0.2	<0.2	< 0.2	< 0.2

Heavy Metals / Metalloids							
Arsenic (dissolved)	ug/l	WFD 14	50	<1.0	39.00	39	2.2
Boron (dissolved)	ug/l	EQS Annex VII	2,000	120.00	170.00	120	170
Cadmium (dissolved)	ug/l	DEP 08	0.08	<0.08	<0.08	< 0.08	< 0.08
Chromium (hexavalent)	ug/l	WFD 14	3.4	<5.0	<5.0	< 5.0	< 5.0
Chromium (dissolved)	ug/l	WFD 14	4.7	0.00	0.00	0	0
Copper (dissolved)	ug/l	WFD 14	1	12.00	21.00	21	12
Lead (dissolved)	ug/l	GUK 18	1.2	<1.0	1.50	1.5	< 1.0
Mercury (dissolved)	ug/l	DEP 08 MAC	0.07	<0.5	<0.5	< 0.5	< 0.5
Nickel (dissolved)	ug/l	GUK 18	4	2.00	8.40	8.4	2
Selenium (dissolved)	ug/l	N/A	N/A	<4.0	<4.0	< 4.0	< 4.0
Zinc (dissolved)	ug/l	WFD 14	10.9	9.70	84.00	84	9.7

Monoaromatics							
Benzene	ug/l	GUK 18	10	<1.0	<1.0	< 3.0	< 3.0
Toluene	ug/l	WFD 14	74	<1.0	<1.0	< 3.0	< 3.0
Ethylbenzene	ug/l	EQS R&D	20	<1.0	<1.0	< 3.0	< 3.0
p & m-xylene	ug/l	RBD	30	<1.0	<1.0	< 3.0	< 3.0
o-xylene	ug/l	RBD	30	<1.0	<1.0	< 3.0	< 3.0
MTBE	ug/l	N/A	N/A	<10	<10	< 10	< 10

Petroleum Hydrocarbons							
Aliphatic >C5 - C6	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aliphatic >C6 - C8	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aliphatic >C8 - C10	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aliphatic >C10 - C12	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aliphatic >C12 - C16	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aliphatic >C16 - C21	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aliphatic >C21 - C35	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aliphatic (C5 - C35)	ug/l	N/A	N/A	<10	<10	< 10	< 10

Petroleum Hydrocarbons							
Aromatic >C5 - C7	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aromatic >C7 - C8	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aromatic >C8 - C10	ug/l	N/A	N/A	<1.0	<1.0	< 1.0	< 1.0
Aromatic >C10 - C12	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aromatic >C12 - C16	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aromatic >C16 - C21	ug/l	N/A	N/A	<10	<10	< 10	< 10
Aromatic >C21 - C35	ug/l	N/A	N/A	<10	<10	< 10	< 10
Total >C5 - C35	ug/l	N/A	N/A	<10	<10	< 10	< 10

Key	
Document	Source Reference
Water Framework Directive implementation in England and Wales (PB 14163, 2014) - fresh water only, for saltwater guidelines refer to the document	WFD 14
Directive 2008/105/EC of the European Parliament and of the Council (L 348/84, 2008), value adopted is the AA (annual average)	DEP 08
Environmental Quality Standards for Annex VIII Substances, UK TAG	EQS for Annex VIII
Directive 2008/105/EC of the European Parliament and of the Council (L 348/84, 2008), value adopted is the MAC (Maximum Allowable Concentration)	DEP 08 MAC
Proposed Environmental Quality Standards for Ethylbenzene in Water R&D Technical Report P2-115/TR4 (Annual Average) 2002	EQS R&D
The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. Annual Average EQS (surface waters).	RBD
Gov.UK April 2018. Surface water pollution risk assessment for your environmental permit. (www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit).	GUK 18

TRC Companies Ltd - Chemical Assessment Record			
Contract Engineer		Jonathon Sander	
Project/Site Name		Crabtree Lane	
Project Number		546629.0000.0000	

Sample Reference	WS101	BH101
Depth	2.30	2.50
Date Sampled	24/05/2023	26/05/2023
Time Taken	0.0	0.0

Determinand	Unit	Source	Screening Criteria	Min	Max		
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General Inorganics

	Units	N/A	N/A	5.80	8.00	5.8	8
pH							
Electrical Conductivity at 20 °C	µS/cm	N/A	N/A	0	0	0	0
Total Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0
Complex Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0
Free Cyanide	µg/l	N/A	N/A	0.00	0.00	0	0
Thiocyanate as SCN	µg/l	N/A	N/A	0.00	0.00	0	0
Sulphate as SO ₄	µg/l	N/A	N/A	0	0	0	0
Sulphate as SO ₄	mg/l	N/A	N/A	0.00	0.00	0	0
Total Sulphur	µg/l	N/A	N/A	0	0	0	0
Sulphide	µg/l	N/A	N/A	0.00	0.00	0	0
Chloride	mg/l	N/A	N/A	0.00	0.00	0	0
Ammonium as NH ₄	µg/l	N/A	N/A	0	0	0	0
Dissolved Organic Carbon (DOC)	mg/l	N/A	N/A	0.00	0.00	0	0
Total Suspended Solids	mg/l	N/A	N/A	0	0	0	0

Phenols by HPLC

	µg/l	N/A	N/A	0.00	0.00	0	0
Catechol							
Resorcinol	µg/l	N/A	N/A	0.00	0.00	0	0
Ethylphenol & Dimethylphenol	µg/l	N/A	N/A	0.00	0.00	0	0
Cresols	µg/l	N/A	N/A	0.00	0.00	0	0
Naphthols	µg/l	N/A	N/A	0.00	0.00	0	0
Isopropylphenol	µg/l	N/A	N/A	0.00	0.00	0	0
Phenol	µg/l	N/A	N/A	0.00	0.00	0	0
Trimethylphenol	µg/l	N/A	N/A	0.00	0.00	0	0

Total Phenols

Total Phenols (HPLC)	µg/l	N/A	N/A	0.00	0.00	0	0
----------------------	------	-----	-----	------	------	---	---

Speciated PAHs

	ug/l	SOBRA 17	23000	0.00	0.00	< 0.01	< 0.01
Naphthalene (aq)							
Acenaphthene (aq)	ug/l	SOBRA 17	15000000	0.00	0.00	< 0.01	< 0.01
Acenaphthylene (aq)	ug/l	SOBRA 17	20000000	0.00	0.00	< 0.01	< 0.01
Fluoranthene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Anthracene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Phenanthrene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Fluorene (aq)	ug/l	SOBRA 17	18000000	0.00	0.00	< 0.01	< 0.01
Chrysene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Pyrene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Benzo(a)anthracene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Benzo(b)fluoranthene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Benzo(k)fluoranthene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Benzo(a)pyrene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Dibenzo(a,h)anthracene (aq)	ug/l	N/A	N/A	0.00	0.00	< 0.01	< 0.01
Benzo(g,h,i)perylene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Indeno(1,2,3-cd)pyrene (aq)	ug/l	SOBRA 17	N/A	0.00	0.00	< 0.01	< 0.01
Total EPA-16 PAHs	ug/l	N/A	N/A	0.00	0.00	< 0.2	< 0.2

Heavy Metals / Metalloids

	ug/l	N/A	N/A	2.20	39.00	39	2.2
Arsenic (dissolved)							
Boron (dissolved)	ug/l	N/A	N/A	120.00	170.00	120	170
Cadmium (dissolved)	ug/l	N/A	N/A	0.00	0.00	< 0.005	< 0.005
Chromium (hexavalent)	ug/l	N/A	N/A	0.00	0.00	< 5.0	< 5.0
Chromium (dissolved)	ug/l	N/A	N/A	0.00	0.00	0	0
Copper (dissolved)	ug/l	N/A	N/A	12.00	21.00	21	12
Lead (dissolved)	ug/l	N/A	N/A	1.50	1.50	1.5	< 1.0
Mercury (dissolved)	ug/l	N/A	N/A	0.00	0.00	< 0.5	< 0.5
Nickel (dissolved)	ug/l	N/A	N/A	2.00	8.40	8.4	2
Selenium (dissolved)	ug/l	N/A	N/A	0.00	0.00	< 4.0	< 4.0
Zinc (dissolved)	ug/l	N/A	N/A	9.70	84.00	84	9.7

Monoaromatics

	ug/l	SOBRA 17	20000	0.00	0.00	< 3.0	< 3.0
Benzene							
Toluene	ug/l	SOBRA 17	230000	0.00	0.00	< 3.0	< 3.0
Ethylbenzene	ug/l	SOBRA 17	960000	0.00	0.00	< 3.0	< 3.0
p & m-xylene	ug/l	SOBRA 17	94000	0.00	0.00	< 3.0	< 3.0
o-xylene	ug/l	SOBRA 17	1100000	0.00	0.00	< 3.0	< 3.0
MTBE	ug/l	SOBRA 17	7800000	0.00	0.00	< 30	< 10

Petroleum Hydrocarbons

	ug/l	SOBRA 17	193000	0.00	0.00	< 1.0	< 1.0
Aliphatic >C5 - C6							
Aliphatic >C6 - C8	ug/l	SOBRA 17	148000	0.00	0.00	< 1.0	< 1.0
Aliphatic >C8 - C10	ug/l	SOBRA 17	5650	0.00	0.00	< 1.0	< 1.0
Aliphatic >C10 - C12	ug/l	SOBRA 17	3640	0.00	0.00	< 10	< 10
Aliphatic >C12 - C16	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aliphatic >C16 - C21	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aliphatic >C21 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aliphatic (C5 - C35)	ug/l	N/A	N/A	0.00	0.00	< 10	< 10

Petroleum Hydrocarbons

	ug/l	SOBRA 17	20200000	0.00	0.00	< 1.0	< 1.0
Aromatic >C5 - C7							
Aromatic >C7 - C8	ug/l	SOBRA 17	21100000	0.00	0.00	< 1.0	< 1.0
Aromatic >C8 - C10	ug/l	SOBRA 17	191000	0.00	0.00	< 1.0	< 1.0
Aromatic >C10 - C12	ug/l	SOBRA 17	664000	0.00	0.00	< 10	< 10
Aromatic >C12 - C16	ug/l	SOBRA 17	3680000	0.00	0.00	< 10	< 10
Aromatic >C16 - C21	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Aromatic >C21 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10
Total >C5 - C35	ug/l	N/A	N/A	0.00	0.00	< 10	< 10

Annex G: Laboratory Geotechnical Data

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WD25 9XX

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Fax: +44(0) 1923 892 191
email: admin@geolabs.co.uk
web: www.geolabs.co.uk

TRC Companies Limited
2 Mount Street
Manchester
M2 5WQ

26 June 2023

Report No : GEO/38201/01

Page 1 of 1

For the attention of Mr M Dorfling

Our ref **GEO / 38201**
Your Ref **546629**

Date samples received 01/06/2023
Date written instructions received 01/06/2023
Date testing commenced 02/06/2023
Date of sample disposal 24/07/2023

Project **CRABTREE LANE, MANCHESTER**

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

Item No	Test Quantity	Description
1	~	Geotechnical Test Summary
~	8	Water Content
~	4	Liquid & Plastic Limits
~	9	pH Value & Water Soluble Sulphate Content as SO4
2	5	Particle Size Distribution

Any opinions or interpretations expressed herein are outside the scope of UKAS accreditation. All results contained in this report are provisional unless signed by an approved signatory. The results contained in this report relate only to samples received in the laboratory and are tested 'as received' unless otherwise stated. This report should not be reproduced, except in full, without the written approval of the laboratory. The results reported are applicable only to the test items received by the laboratory.

All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
on behalf of **GEOLABS Limited**



S Burke
Senior Technician

SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression				Chemical Tests			Other tests and comments
Location	Depth (m)	Sample Ref	Type	Description	WC	LL	PL	PI	<425 µm	Bulk	Dry	Condition	Cell Pressure	Deviator Stress	Shear Stress	pH	2:1 W/S SO4	W/S Mg	
					%	%	%	%	%	Mg/m³	Mg/m³		kPa	kPa	kPa		g/L	mg/L	
BH101	3.00	2023-05-26	D	Dark brown sandy gravelly silty CLAY.	29.8											8.0	0.060		Particle Size Distribution
BH101	5.00	2023-05-26	D	Brown slightly gravelly sandy silty CLAY.	24.8	41	21	20	91							8.3	< 0.010		Particle Size Distribution
BH102	1.20	2023-05-25	D	Dark brown clayey silty gravelly SAND. Gravel includes brick fragments.	17.2											7.9	0.47		Particle Size Distribution
BH102	3.00	2023-05-24	D	Dark brown sandy silty CLAY with rare fine to medium gravel.	16.3	41	18	23	99							8.3	< 0.010		
BH102	5.00	2023-05-25	B	Brown silty clayey SAND and GRAVEL.	12.5											8.4	0.023		Particle Size Distribution
BH102	9.00	2023-05-25	B	Dark brown mottled brown silty SAND.	24.3														
WS104	0.80	2023-05-24	D													7.3	1.4		
WS104	4.20	2023-05-24	D	Dark brown sandy silty CLAY with some rare fine gravel.	17.3	41	18	23	99							8.2	0.17		
WS105	2.70	2023-05-25	D	Black and yellowish brown sandy gravelly clayey SILT. Gravel is fine to medium.	40.1	50	31	19	74							6.8	0.22		
WS107	0.90	2023-05-25	D	Dark brown silty very sandy GRAVEL.												8.1	0.49		Particle Size Distribution

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by



S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

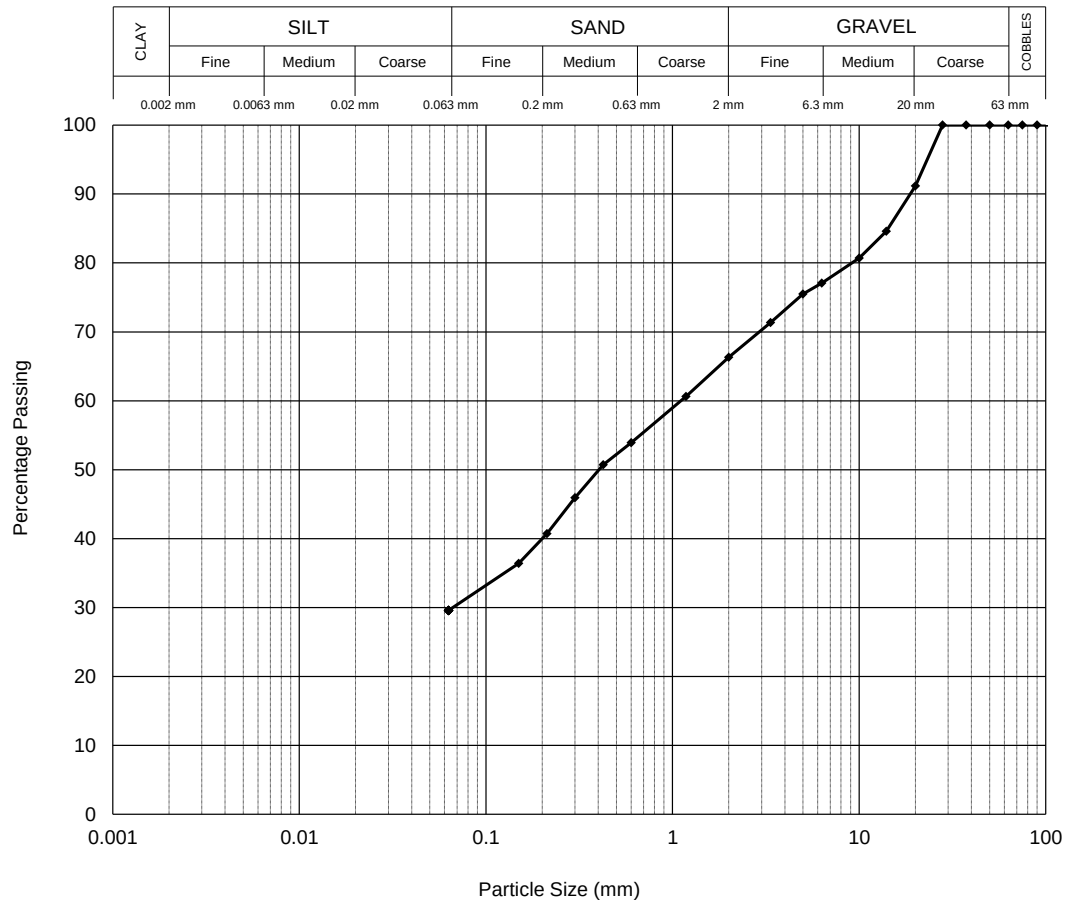
Location **BH101**
Sample Ref **2023-05-26**
Depth (m) 3.00
Sample Type D

Description

Dark brown sandy gravelly silty CLAY.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	91
14.0 mm	85
10.0 mm	81
6.30 mm	77
5.00 mm	76
3.35 mm	71
2.00 mm	66
1.18 mm	61
600 µm	54
425 µm	51
300 µm	46
212 µm	41
150 µm	36
63 µm	30



Particle Proportions	
Cobbles	0.0
Gravel	33.7
Sand	36.7
Silt & Clay	29.6

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

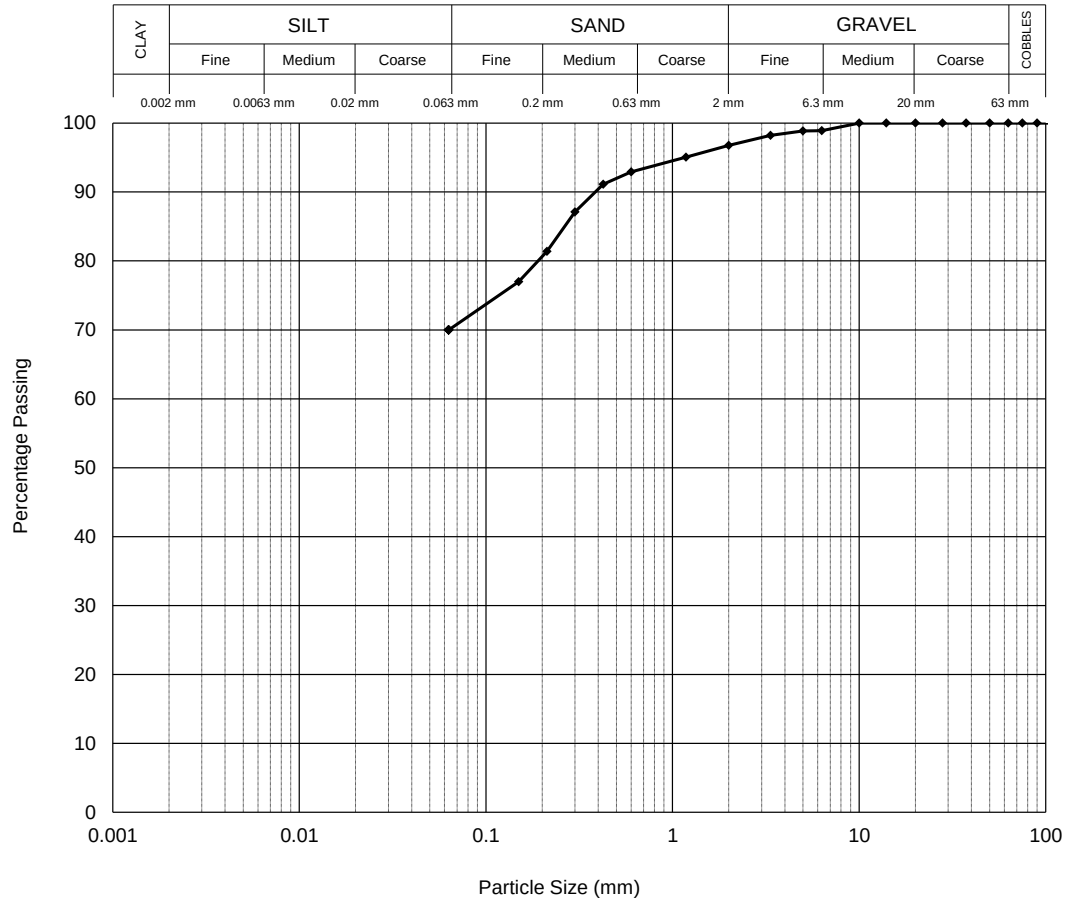
Location BH101
Sample Ref 2023-05-26
Depth (m) 5.00
Sample Type D

Description

Brown slightly gravelly sandy silty CLAY.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	99
5.00 mm	99
3.35 mm	98
2.00 mm	97
1.18 mm	95
600 µm	93
425 µm	91
300 µm	87
212 µm	81
150 µm	77
63 µm	70



Particle Proportions	
Cobbles	0.0
Gravel	3.2
Sand	26.8
Silt & Clay	70.0

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

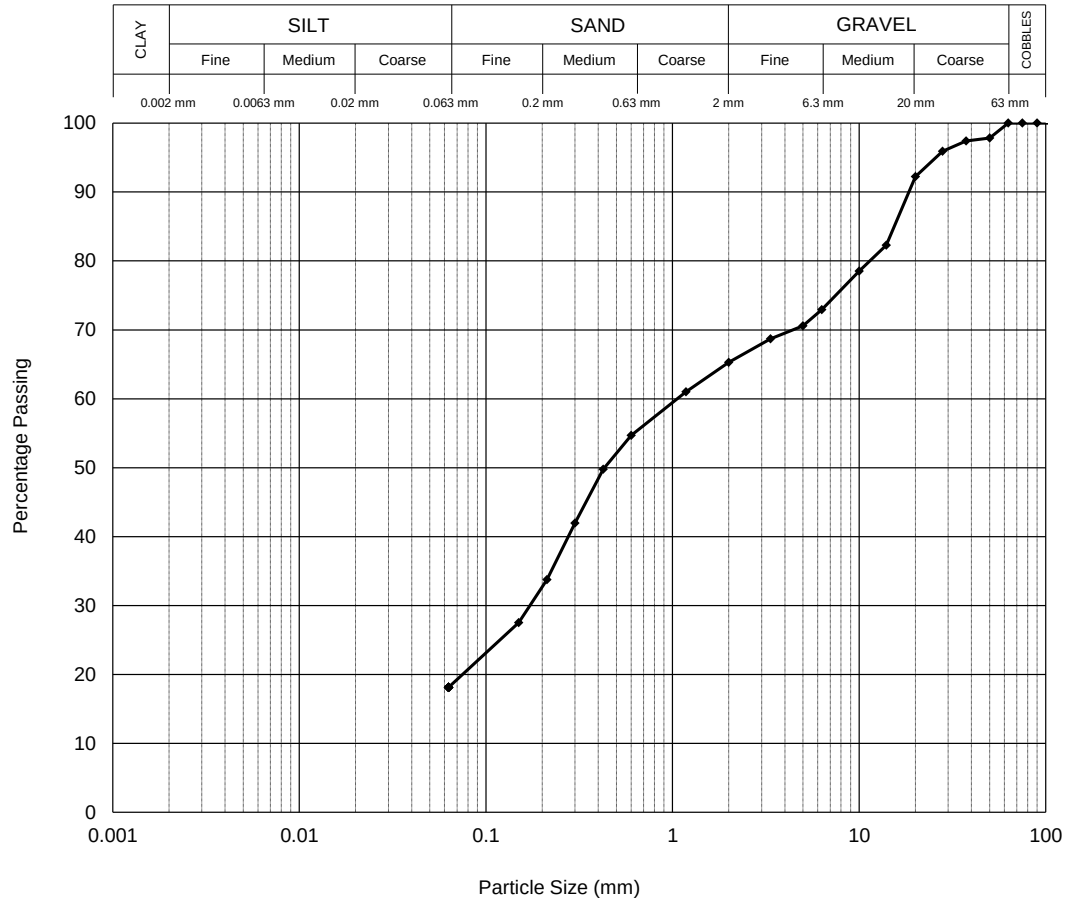
Location **BH102**
Sample Ref **2023-05-25**
Depth (m) 1.20
Sample Type D

Description

Dark brown clayey silty gravelly SAND. Gravel includes brick fragments.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	98
37.5 mm	97
28.0 mm	96
20.0 mm	92
14.0 mm	82
10.0 mm	79
6.30 mm	73
5.00 mm	71
3.35 mm	69
2.00 mm	65
1.18 mm	61
600 µm	55
425 µm	50
300 µm	42
212 µm	34
150 µm	28
63 µm	18



Particle Proportions	
Cobbles	0.0
Gravel	34.7
Sand	47.2
Silt & Clay	18.1

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

**CRABTREE LANE, MANCHESTER
546629**



PARTICLE SIZE DISTRIBUTION

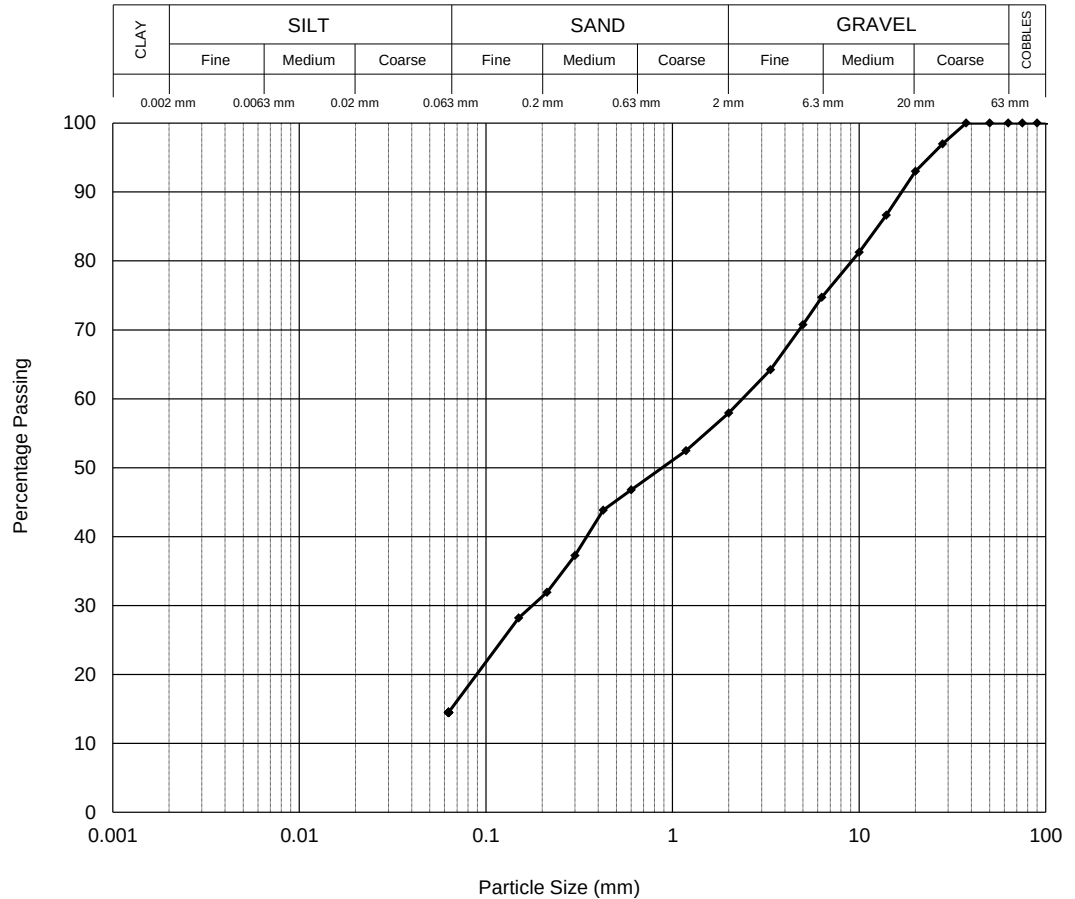
Location BH102
Sample Ref 2023-05-25
Depth (m) 5.00
Sample Type B

Description

Brown silty clayey SAND and GRAVEL.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	97
20.0 mm	93
14.0 mm	87
10.0 mm	81
6.30 mm	75
5.00 mm	71
3.35 mm	64
2.00 mm	58
1.18 mm	52
600 µm	47
425 µm	44
300 µm	37
212 µm	32
150 µm	28
63 µm	14



Particle Proportions	
Cobbles	0.0
Gravel	42.0
Sand	43.5
Silt & Clay	14.5

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

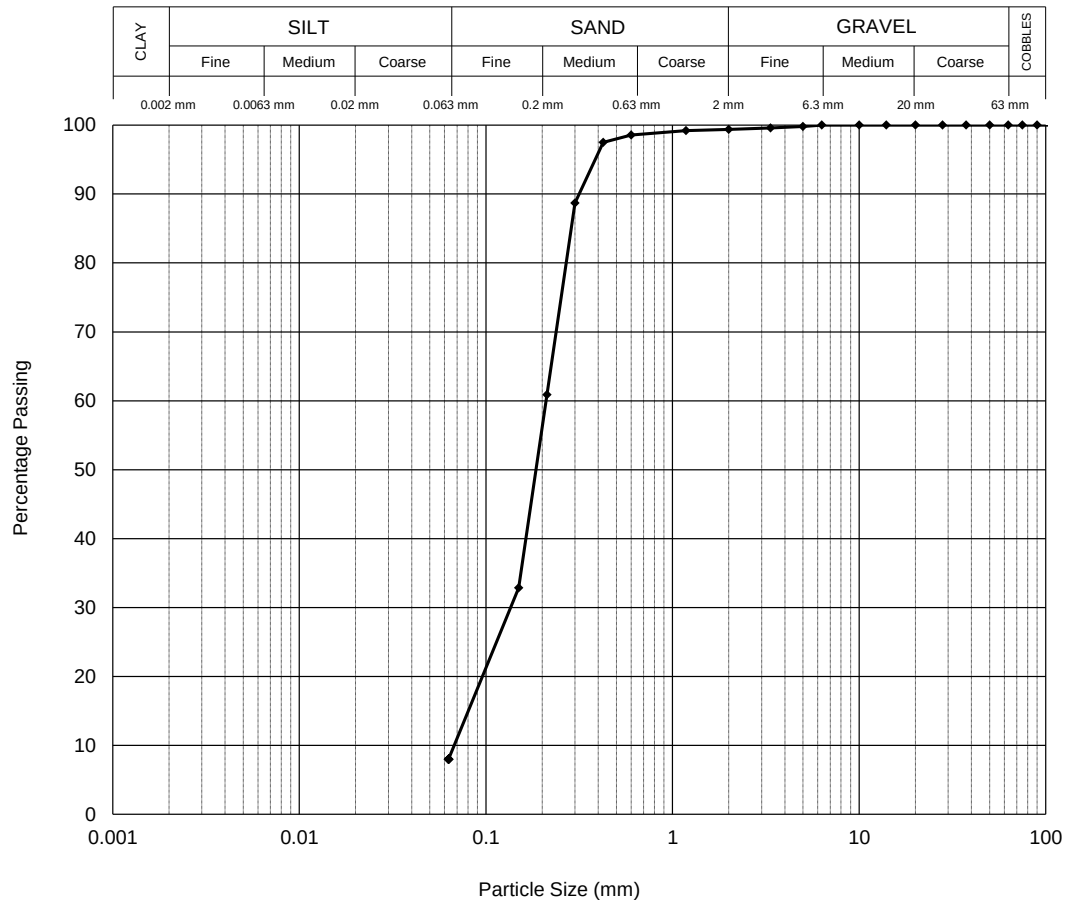
Location BH102
Sample Ref 2023-05-25
Depth (m) 9.00
Sample Type B

Description

Dark brown mottled brown silty SAND.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	100
5.00 mm	100
3.35 mm	100
2.00 mm	99
1.18 mm	99
600 µm	99
425 µm	97
300 µm	89
212 µm	61
150 µm	33
63 µm	8



Particle Proportions	
Cobbles	0.0
Gravel	0.6
Sand	91.4
Silt & Clay	8.0

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

Location
Sample Ref
Depth (m)
Sample Type

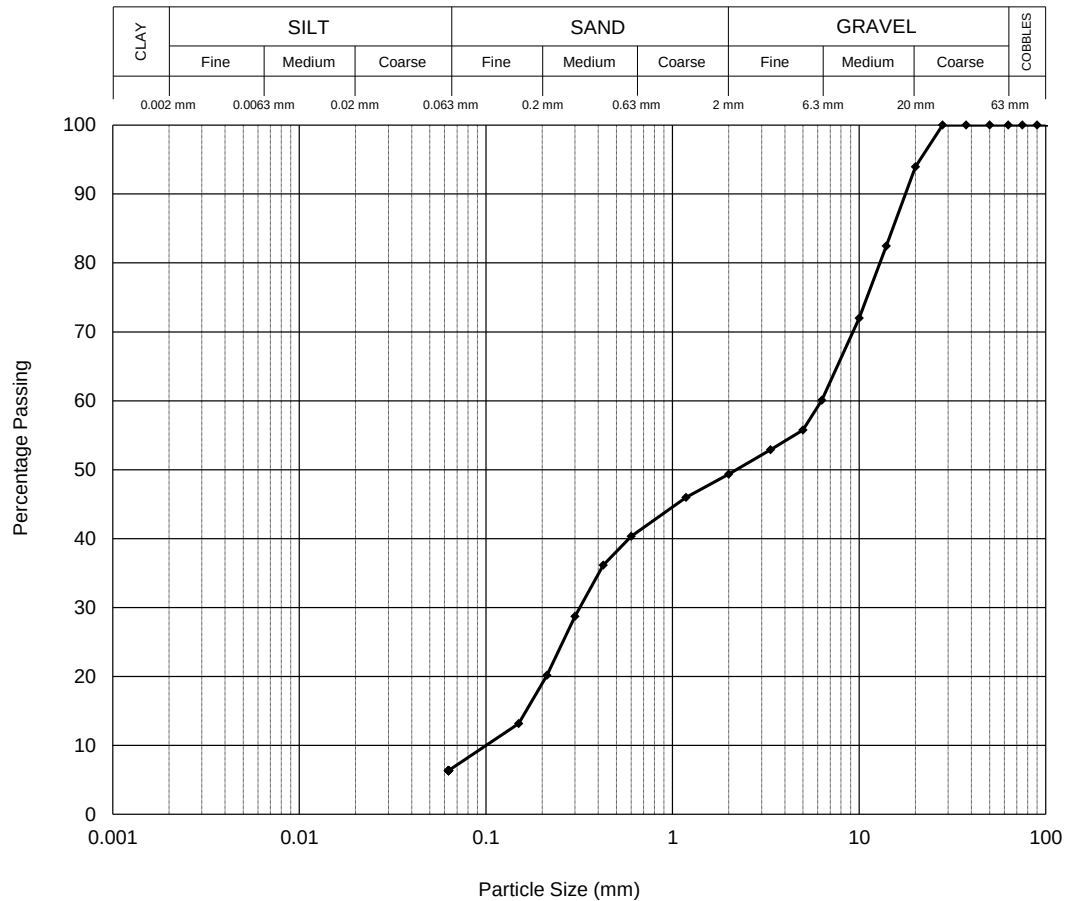
WS107
2023-05-25
0.90
D

Description

Dark brown silty very sandy GRAVEL.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	94
14.0 mm	82
10.0 mm	72
6.30 mm	60
5.00 mm	56
3.35 mm	53
2.00 mm	49
1.18 mm	46
600 µm	40
425 µm	36
300 µm	29
212 µm	20
150 µm	13
63 µm	6



Particle Proportions	
Cobbles	0.0
Gravel	50.7
Sand	43.0
Silt & Clay	6.3

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
26/06/2023

Project Number:

GEO / 38201

Project Name:

CRABTREE LANE, MANCHESTER
546629



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12 July 2023

Report No : GEO/38299/01

Page 1 of 1

For the attention of Mr M Dorfling

Our ref **GEO / 38299**
Your Ref **546629**

Date samples received 15/06/2023
Date written instructions received 19/06/2023
Date testing commenced 20/06/2023
Date of sample disposal 09/08/2023

Project **CRABTREE LANE, MANCHESTER**

Further to your instructions we have pleasure in enclosing the results of the tests you requested in the attached figures.

LABORATORY TEST REPORT

Item No	Test Quantity	Description
1	~	Geotechnical Test Summary
~	3	Water Content
~	3	Liquid & Plastic Limits
~	5	pH Value & Water Soluble Sulphate Content as SO4
2	4	Particle Size Distribution
3	2	Unconsolidated Undrained Triaxial Compression

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All the necessary data required by the documented test procedures has been recorded and will be stored for a period of not less than 6 years. This data will be issued to yourselves at your request. All samples will be disposed of after the date shown above. Written confirmation will be required to retain the samples beyond this period and a storage charge may be applied.

We trust that the above meets your requirements and should you require any further information or assistance, please do not hesitate to contact us.

Yours faithfully
on behalf of **GEOLABS Limited**



S Burke
Senior Technician

SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression				Chemical Tests			Other tests and comments
Location	Depth (m)	Sample Ref	Type	Description	WC	LL	PL	PI	<425 µm	Bulk	Dry	Condition	Cell Pressure	Deviator Stress	Shear Stress	pH	2:1 W/S SO4	W/S Mg	
					%	%	%	%	%	Mg/m³	Mg/m³		kPa	kPa	kPa		g/L	mg/L	
BH202	1.20		D	Dark brown slightly silty clayey very sandy GRAVEL. Gravel includes brick.												8.4	0.098		Particle Size Distribution
BH202	3.00		U	Very stiff brown slightly gravelly sandy silty CLAY. Gravel is fine.	23.1					2.14	1.74	Undisturbed	90	445	222				
BH202	5.00	SPT	D	Orangish brown slightly clayey gravelly SAND. Gravel is fine to medium.												8.8	< 0.010		Particle Size Distribution
BH202	9.00	SPT	D	Greyish brown fine to medium SAND.															Particle Size Distribution
BH202	13.50	SPT	D	Dark brown sandy silty CLAY.	14.2	30	14	16	100										
BH203	0.50	SPT	D													5.8	1.4		
BH203	2.00		B	Dark brown gravelly CLAY.	22.7	44	20	24	85							7.7	0.74		
BH203	3.00		U	Stiff brown sandy silty CLAY. Sand is fine.	19.8					2.14	1.78	Undisturbed	90	302	151				
BH203	8.00		B	Greyish brown slightly silty fine to medium SAND.															Particle Size Distribution
BH203	9.50	SPT	D	Dark brown silty slightly gravelly CLAY. Gravel is fine to medium.	20.0	27	16	11	99							7.8	0.088		

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by  S Burke - Senior Technician 12/07/2023	<table style="width: 100%;"> <tr> <td style="width: 30%;">Project Number:</td> <td style="text-align: center;">GEO / 38299</td> </tr> <tr> <td>Project Name:</td> <td style="text-align: center;">CRABTREE LANE, MANCHESTER 546629</td> </tr> </table>	Project Number:	GEO / 38299	Project Name:	CRABTREE LANE, MANCHESTER 546629	
Project Number:	GEO / 38299					
Project Name:	CRABTREE LANE, MANCHESTER 546629					

PARTICLE SIZE DISTRIBUTION

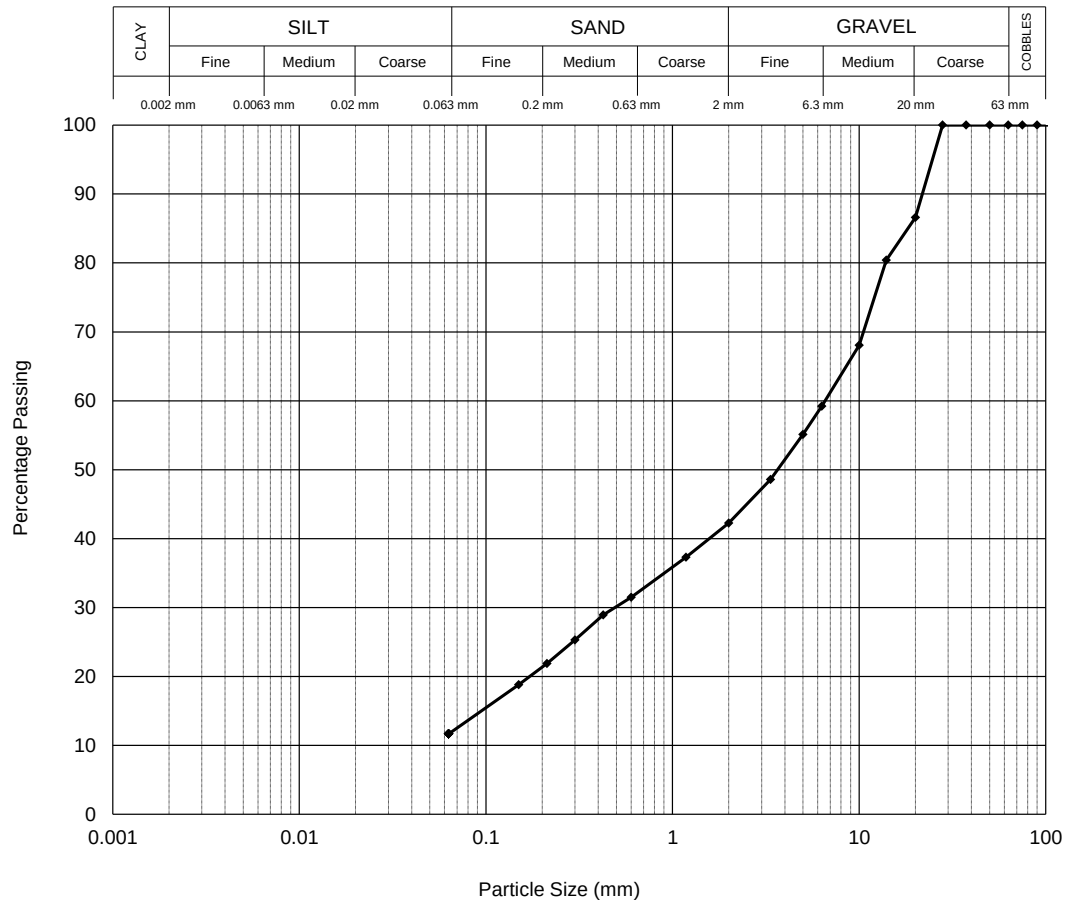
Location BH202
Depth (m) 1.20
Sample Type D

Description

Dark brown slightly silty clayey very sandy GRAVEL. Gravel includes brick.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	87
14.0 mm	80
10.0 mm	68
6.30 mm	59
5.00 mm	55
3.35 mm	49
2.00 mm	42
1.18 mm	37
600 µm	31
425 µm	29
300 µm	25
212 µm	22
150 µm	19
63 µm	12



Particle Proportions	
Cobbles	0.0
Gravel	57.8
Sand	30.6
Silt & Clay	11.6

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
12/07/2023

Project Number:

GEO / 38299

Project Name:

**CRABTREE LANE, MANCHESTER
546629**



PARTICLE SIZE DISTRIBUTION

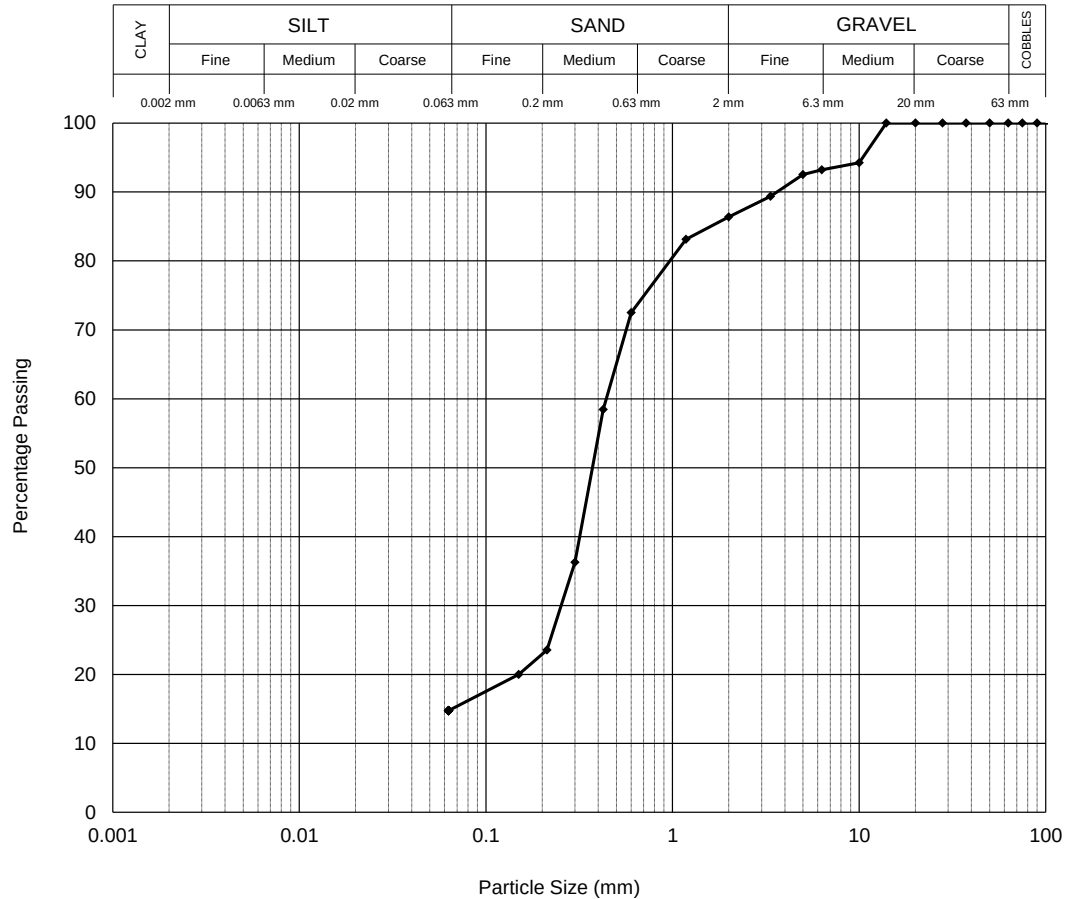
Location BH202
 Sample Ref SPT
 Depth (m) 5.00
 Sample Type D

Description

Orangish brown slightly clayey gravelly SAND. Gravel is fine to medium.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	94
6.30 mm	93
5.00 mm	93
3.35 mm	89
2.00 mm	86
1.18 mm	83
600 µm	72
425 µm	58
300 µm	36
212 µm	24
150 µm	20
63 µm	15



Particle Proportions	
Cobbles	0.0
Gravel	13.6
Sand	71.7
Silt & Clay	14.7

Tested by XW
 Checked and Approved by

S Burke

S Burke - Senior Technician
 12/07/2023

Project Number:

GEO / 38299

Project Name:

**CRABTREE LANE, MANCHESTER
 546629**



PARTICLE SIZE DISTRIBUTION

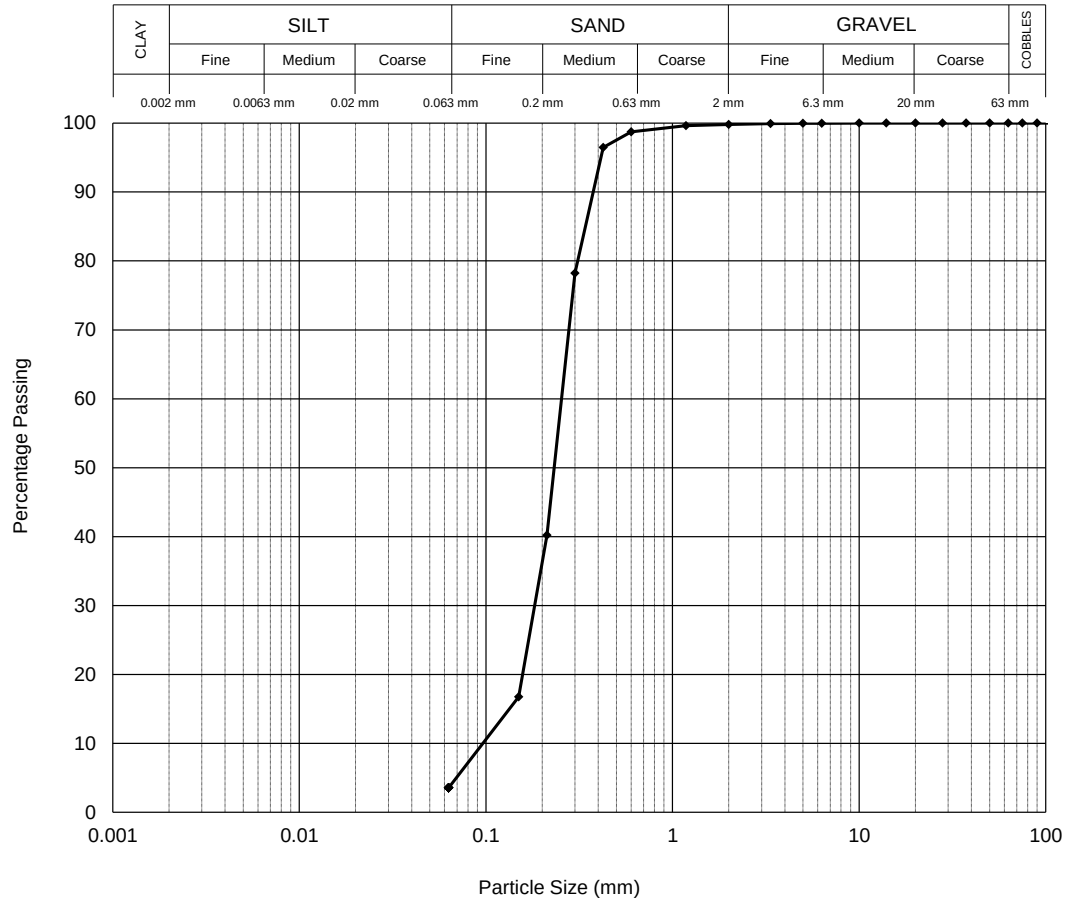
Location BH202
 Sample Ref SPT
 Depth (m) 9.00
 Sample Type D

Description

Greyish brown fine to medium SAND.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	100
5.00 mm	100
3.35 mm	100
2.00 mm	100
1.18 mm	100
600 µm	99
425 µm	96
300 µm	78
212 µm	40
150 µm	17
63 µm	4



Particle Proportions	
Cobbles	0.0
Gravel	0.2
Sand	96.3
Silt & Clay	3.5

Tested by XW
 Checked and Approved by

S Burke

S Burke - Senior Technician
 12/07/2023

Project Number:

GEO / 38299

Project Name:

CRABTREE LANE, MANCHESTER
546629



PARTICLE SIZE DISTRIBUTION

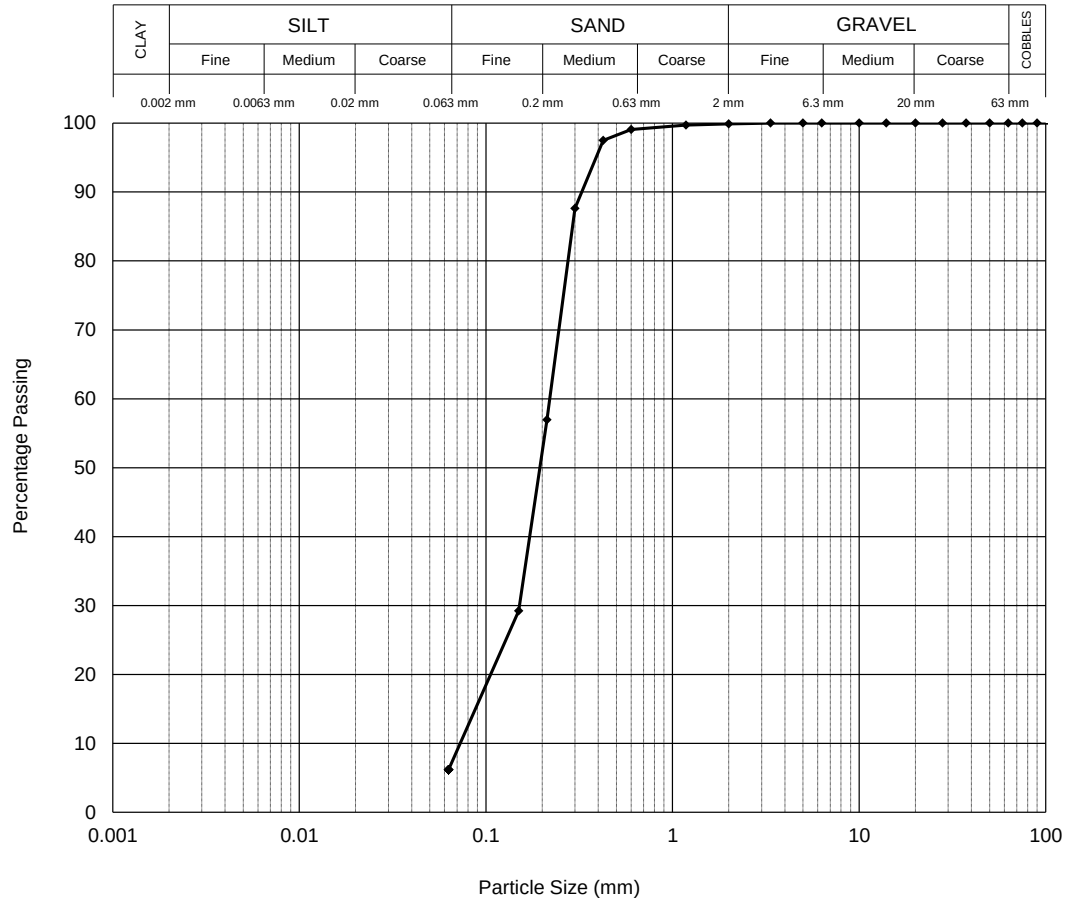
Location BH203
Depth (m) 8.00
Sample Type B

Description

Greyish brown slightly silty fine to medium SAND.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	100
5.00 mm	100
3.35 mm	100
2.00 mm	100
1.18 mm	100
600 µm	99
425 µm	97
300 µm	88
212 µm	57
150 µm	29
63 µm	6



Particle Proportions	
Cobbles	0.0
Gravel	0.1
Sand	93.7
Silt & Clay	6.2

Tested by XW
Checked and Approved by

S Burke

S Burke - Senior Technician
12/07/2023

Project Number:

GEO / 38299

Project Name:

**CRABTREE LANE, MANCHESTER
546629**



UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION

Location BH202
Depth (m) 3.00
Sample Type U

Description:

Very stiff brown slightly gravelly sandy silty CLAY. Gravel is fine.

Specimen Details

Specimen conditions	Undisturbed
Length (mm)	177.7
Diameter (mm)	100.6
Water content (%)	23.1
Bulk density (Mg/m ³)	2.14
Dry density (Mg/m ³)	1.74
Test Details	
Latex membrane thickness (mm)	0.3
Specimen height prior to shearing (mm)	177.6
Membrane correction (kPa)	1.1
Mean rate of shear (%/min)	2.3
Cell pressure (kPa)	90
Strain at failure (%)	19.7
Maximum deviator stress (kPa)	445
Shear Stress Cu (kPa)	222

Mode of failure

Orientation of the sample

Vertical

Distance from top of tube mm

220

Tested by SB
Checked and Approved by



S Burke - Senior Technician
12/07/2023

Project Number:

GEO / 38299

Project Name:

CRABTREE LANE, MANCHESTER
546629



UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION

Location BH203
Depth (m) 3.00
Sample Type U

Description:

Stiff brown sandy silty CLAY. Sand is fine.

Specimen Details

Specimen conditions	Undisturbed
Length (mm)	200.7
Diameter (mm)	100.0
Water content (%)	19.8
Bulk density (Mg/m ³)	2.14
Dry density (Mg/m ³)	1.78
Test Details	
Latex membrane thickness (mm)	0.3
Specimen height prior to shearing (mm)	200.6
Membrane correction (kPa)	1.1
Mean rate of shear (%/min)	2.0
Cell pressure (kPa)	90
Strain at failure (%)	19.9
Maximum deviator stress (kPa)	302
Shear Stress Cu (kPa)	151

Mode of failure

Orientation of the sample

Vertical

Distance from top of tube mm

30

Tested by SB
Checked and Approved by

S Burke - Senior Technician
12/07/2023

Project Number:

GEO / 38299

Project Name:

CRABTREE LANE, MANCHESTER
546629





Client	TRC Companies Limited	TEST RESTRICTION
Project No.	38299	
Project Name	CRABTREE LANE, MANCHESTER	

The following tests have been scheduled on the above project and **CANNOT** be performed for the reason stated. If alternative instructions or samples are available for the restricted tests, please supply details.

Laboratory ID	Location	Sample Ref.	Depth (m)		Type	Test(s) Scheduled			Reason for Restriction	Description
490117	BH202		12.00		U				Sample in pieces very fissured upon extrusion.	Stiff fissured brown sandy CLAY. Sand is fine.
							UU-TXL			
Comments / remarks										Test restriction raised by 

Annex H: Detailed UXO Risk Assessment



1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Former Walkers Site, Crabtree Lane, Manchester
Client	TRC Companies Ltd.
Site Address	Former Walkers Site, Crabtree Lane, Clayton, Manchester M11 4GU
Report Reference	DA17928-00
Date	23 rd May 2023
Authored by	EG
Quality Assurance	HW
Final Check	AT



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Tel: +44 (0)1992 245 020 info@1stlinedefence.co.uk

Executive Summary

Site Location and Description

The site is situated within Clayton, Manchester.

The site is situated approximately 2.95 miles east of Manchester city centre.

The site is bordered to the north by a supermarket and its associated hardstanding car park and a commercial property. Further north of the site is Ashton New Road/A662. East of the site is hardstanding car parking and a commercial property. A supermarket and its associated hardstanding car park is situated further east. South-east of the site is an industrial structure and its associated hardstanding car park. South of the site is a depot and its associated hardstanding car park/storage areas. Further south of the site is shrubbery and Ashton Canal. West of the site is Crabtree Lane. Further west of the site is shrubbery and a large industrial storage area.

Wider surrounds of the site include Hewlett Johnson Playing Fields north of the site.

The majority of the site is occupied by five parallel industrial bays in a somewhat dilapidated state. A newer build industrial bay immediately borders the five main bays on site. A structure with a tin roof is situated within the south-east of the site. A tank is situated within the north-west of the site. An electrical substation is situated within the south-west of the site, with a smaller structure situated within the south-east of the site. Areas of hardstanding are situated within the south-east and west of the site (running from north to south), as well as a in the south of the site. The site is bordered to the north, east and west by shrubbery.

The site is approximately centred on the OS grid reference: **SJ 88758 98230**.

Proposed Works

Information provided by the client indicates the proposed works to include three rotary cored drilling locations down to a depth of 25m.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the site to be underlain by Manchester Marls Formation- Mudstone. Sedimentary bedrock formed between 272.3 and 252.2 million years ago during the Permian period. Superficial deposits are recorded as Till, Devensian- Diamicton. Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period.

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

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

**UXO Risk Assessment**

1st Line Defence has assessed that there is a **Medium Risk** from items of German air delivered UXO. There is also an assessed **Negligible Risk** from Allied UXO across the site. This assessment is based on the following factors:

The Risk from German Air Delivered UXO

- During WWII, the site was situated within the County Borough of Manchester, which was subject to an overall low density of bombing, culminating in an average of 27.1 items of ordnance per 1,000 acres of land, according to official Home Office bombing statistics. Whilst Manchester did not sustain the intense bombing campaign that other cities such as London and Coventry experienced, the area was still subject to a number of significant targeted bombing raids between 1940 and 1941. Luftwaffe target mapping indicates that the city centre was the focus of bombing, which was situated approximately 4.75km west of the site.
- During WWII, the site was occupied by a chemical works and open ground within a heavily industrialised area of Clayton, Manchester.
- Manchester bomb and damage map records seven incendiary bombing to a structure within the east of the site on the 22nd/23rd 1940. Incendiary bombing is also recorded to the Picture Theatre which immediately bordered the site to the north. A number of incendiary bombing incidents are recorded within close proximity to the site. This map records a structure within the east of the site as damaged.
- War Damage to property cards records an A.A projectile at the on-site chemical works on the same date as the above discussed incendiary bomb. Damage is recorded to the roof and glass of this structure. As this incident is the same date as the recorded incendiary bombing across the site, it is possible the incendiary bombing on site was incorrectly plotted.
- Whilst 1948 aerial photography is of low quality, white roofing indicative of repair works is visible across the eastern structure, with cleared ground visible south of the site. The level of repairs/areas of clearance in WWII-era aerial imagery is consistent with post-war OS mapping, which records *Ruins* which extend south of the site.
- It is considered that ground conditions within the areas of damage within the site would have been generally unfavourable to the observation of evidence of UXO. In the recorded areas of damage and the open ground conditions, UXB entry holes, which could have been as small as 20cm in diameter, could easily have been obscured by debris and soft ground.
- Following the recorded bomb strikes and damage, access to the site would have partially ceased or reduced altogether. Given the bomb damage map records the chemical works as disused, it is possible the structure on site was abandoned prior to the outbreak of war. In this case, it is not possible to attest how frequent the site would have been accessed. As such, post-raid checks are unlikely to have occurred within abandoned properties.
- In summary, evidence indicates the site was situated within an industrial area of Manchester which was subject to a number of bombing incidents and damage. There were a number of inconsistencies with the record sets, which suggest further incidents and damage occurred within the immediate vicinity and were not recorded. The Manchester bomb and damage map records incendiary bombing on site, whereas war damage to property cards record an A.A projectile to the chemical works. Given the bomb and damage map is not considered comprehensive, it is possible that additional strikes may have fallen on site and were not recorded. Furthermore, ruins are recorded south of the site which is not recorded on the damage map
- Following the recorded bombing and open areas of the site ground conditions are not considered conducive to the observation of UXB entry holes. Coupled with this, as the chemical works on site was recorded as disused it is not anticipated that post-raid checks to the site would have been frequent. As such, the site has been deemed at **Medium Risk**.

The Risk from Allied UXO

- There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA.
- The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding air delivered ordnance.

UXO Risk Assessment**Post-WWII Redevelopment**

- Post-WWII the composition of the site has mostly remained the same, occupied by an industrial structure and open areas within the east and west of the site.
- The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. For example, the risk from deep buried UXO will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will however remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Former Walkers Site, Crabtree Lane, Manchester:

All Works

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

Open Excavations (trial pits, service pits, bulk excavations, strip foundations etc.)

- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.

Note – proactive on-site UXO support/survey should not be necessary for any works taking place at the location of and down to the depths of significantly worked post-war made ground/post-war fill.

Glossary

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

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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Former Walkers Site, Crabtree Lane, Manchester
Client: TRC Companies Ltd.

1. Introduction

1.1. Background

1st Line Defence has been commissioned by TRC Companies Ltd. to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at the Former Walkers Site, Crabtree Lane, Manchester.

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

UXO in the UK can originate from three principal sources:

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

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

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

2. Method Statement

2.1. Report Objectives

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

2.2. Risk Assessment Process

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

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

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

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

2.3. Sources of Information

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

- The National Archives and Manchester Central Library.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by TRC Companies Ltd.
- Available material from 33 Engineer Regiment (EOD) Archive (part of 29 Explosive Ordnance and Disposal and Search Group).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

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

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

3.2. German Bombing Records

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

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

3.3. Allied Records

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

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

4. UK Regulatory Environment and Guidelines

4.1. General

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

4.2. CDM Regulations 2015

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

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

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

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

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

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

4.4. CIRIA C681

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

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

4.5. Additional Legislation

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

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

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

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

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

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

5.2. The Authorities

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

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

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

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

6. The Site

6.1. Site Location

The site is situated within Clayton, Manchester.

The site is bordered to the north by a supermarket and its associated hardstanding car park and a commercial property. Further north of the site is Ashton New Road/A662. East of the site is hardstanding car parking and a commercial property. A supermarket and its associated hardstanding car park is situated further east. South-east of the site is an industrial structure and its associated hardstanding car park. South of the site is a depot and its associated hardstanding car park/storage areas. Further south of the site is shrubbery and Ashton Canal. West of the site is Crabtree Lane. Further west of the site is shrubbery and a large industrial storage area.

Wider surrounds of the site include Hewlett Johnson Playing Fields north of the site. The site is approximately centred on the OS grid reference: **SJ 88758 98230**.

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

6.2. Site Description

The majority of the site is occupied by five parallel industrial bays in a somewhat dilapidated state. A newer build industrial bay immediately borders the five main bays on site. A structure with a tin roof is situated within the south-east of the site. A tank is situated within the north-west of the site. An electrical substation is situated within the south-west of the site, with a smaller structure situated within the south-east of the site. Areas of hardstanding are situated within the south-east and west of the site (running from north to south), as well as in the south of the site. The site is bordered to the north, east and west by shrubbery.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

Information provided by the client indicates the proposed works to include three rotary cored drilling locations down to a depth of 25m.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the site to be underlain by Manchester Marls Formation- Mudstone. Sedimentary bedrock formed between 272.3 and 252.2 million years ago during the Permian period. Superficial deposits are recorded as Till, Devensian- Diamicton. Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period.

8.2. Site-Specific Geology

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

9. Site History

9.1. Introduction

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

9.2. Ordnance Survey Historical Maps

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

Pre-WWII		
Date	Scale	Description
1932-1933	1:2,500	Pre-WWII OS mapping indicates the site was occupied by structures associated with a <i>Chemical Works</i> in the east and south of the site. In the south-east and north/north-west of the site was open ground. North of the site was a <i>Picture Theatre</i> and unnamed structures. Further north of the site was tramway. North-east of the site was open ground and residential terraced properties. Smaller square structures are situated north-east of the site. East of the site was open ground. South of the site was a number of small industrial structures thought to be associated with the <i>Chemical Works</i> . Further south of the site was <i>Manchester & Ashton Under Lyne Canal</i> . West of the site was <i>Crabtree Lane</i> . Further west of the site was residential terraced properties, and <i>Tower Chemical Works</i> .

Post-WWII		
Date	Scale	Description
1951-1952	1:2,500	Post-war OS mapping indicates the site was mostly occupied by <i>Plywood Keg Works</i> . The majority of the remainder of the site was occupied by open ground. Small structures were situated within the east, south and south-west of the site. A wall was situated within the south of the site. An <i>Electrical Substation</i> was situated within the west of the site and a structure was situated within the north-west of the site. The site was bordered to the north by a <i>Cinema</i> and a <i>Garage</i> with two other smaller structures. Further north of the site was <i>Ashton New Road</i> . North-east of the site was residential terraced properties. A structure immediately bordered the site to the east. East of the site was <i>Carlton Works (Scrap Metal)</i> and its associated smaller structures and open ground. Further east of the site was a <i>Lime Pit</i> . South of the site was two structures labelled as <i>Ruin</i> . Further south of the site was <i>Ashton Under Lyne Canal</i> . West of the site was <i>Crabtree Lane</i> . Further west of the site was residential terraced properties and a large area of open ground.

10. Introduction to German Air Delivered Ordnance

10.1. General

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

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

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

10.2. Generic Types of WWII German Air Delivered Ordnance

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

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

10.3. Failure Rate of German Air Delivered Ordnance

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

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

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

10.4. UXB Ground Penetration

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

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

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

10.4.1. The J-Curve Effect Principle

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

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were drawn predicting the likely average and maximum depths of penetration of different sized bombs in different geological strata.

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

10.4.3. Site Specific Bomb Penetration Considerations

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

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

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

10.5. V-Weapons

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

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. This limitation of capability meant targets in Manchester were generally too far to be considered for V-weapon strikes by the Luftwaffe. The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

11. The Likelihood of Contamination from German Air Delivered UXBs

11.1. World War I

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

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density, the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of the County Borough of Manchester

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

During WWII the site was located within the County Borough of Manchester, which sustained an overall low density of bombing, as represented by bomb density data figures below. Manchester was not targeted with the same intensity and frequency as other major British cities such as Liverpool, Coventry and Birmingham, however it was still subject to several major raids. The Manchester Blitz was commonly called the 'Christmas Blitz'. Raids began in August and September 1940. The heaviest raids occurred on the nights of 22/23 and 23/24 December 1940, killing an estimated 684 people and injuring 2,364.

Luftwaffe target mapping (**Annex H**) highlights Manchester Central Station and accompanying railway infrastructure as the focus of bombing. The site was situated approximately 4.75km east of Manchester city centre. It is believed that raids were carried out on route to the prominent industrial hub of Salford Docks located to the west of the city. Whilst no specific targets within Gorton were identified, wartime targeting systems tended to be inaccurate and consequently neighbouring areas would often sustain collateral bombing. Moreover, Manchester was protected by a number of barrage balloons which forced aircraft to approach their targets at higher altitudes, thereby further reducing bomb accuracy.

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

Records of bombing incidents are presented in the following sections.

11.3. WWII Home Office Bombing Statistics

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

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		27,255
Weapons	High Explosive bombs (all types)	712
	Parachute mines	18
	Oil bombs	7
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	1
	Long range rockets (V-2)	0
Total		738
Number of Items per 1,000 acres		27.1

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Manchester Bomb and Damage Map

A bomb plot map compiled by Manchester City Council showing high explosive and incendiary bomb strikes on the borough was obtained from the University of Manchester Library. This is primarily concerned with the 'Manchester Blitz' period of 22nd-24th December 1940, though records various other incidents occurring on different dates in 1940 and 1941. The section showing the area of the site is presented in **Annex I**.

Manchester Bomb and Damage Map – Annex I	
Date Range	Comments
1940-1941	This map records the site was occupied by a structure associated with a <i>Chemical Works</i> recorded as (<i>disused</i>.) Seven incendiary bombs are recorded to a structure within the east of the site. The date of this incident is recorded as the 22nd/23rd December 1940. An incendiary bomb was also recorded to the <i>Picture Theatre</i> immediately north of the site. Within the wider area five incendiary bombs are recorded to the <i>Crabtree Forge</i> approximately 100m south of the site. The date of this incident is the 22/23rd December 1940. Five incendiary bombs and damage is recorded to <i>Acre Works</i>, situated approximately 100m south-east of the site. Five incendiary bombs are recorded to the <i>Tower Chemical Works</i> situated approximately 60m west of the site on Crabtree Lane. The date of this incident is the 22nd/23rd December 1940. Additionally, two incendiary bombs are recorded to an industrial structure situated approximately 190m west of the site.

11.5. Interactive 'Christmas Blitz' Bomb Map

A local bomb map, compiled by the Manchester Evening News and utilising data from the Commonwealth and War Graves Commission, was consulted during the production of this report. This map, named the Manchester Christmas Blitz Map, shows the locations of civilian deaths in Greater Manchester between 22nd and 24th December 1940. During this two day period, a reported 800 people were killed as a result of air raids.²

As this map only records bombs which resulted in fatalities, it is not considered a comprehensive account of Christmas bombing raids. The closest fatal bomb strike to the site occurred approximately 960m east on John Street. A section of the map showing the site and its surroundings is presented in **Annex J**.

11.6. Manchester Emergency Committee's Log of Bombing Incidents 22-24 December 1940

Blitz Britain: Manchester and Salford by Graham Phythian presents a transcript of the document 'Manchester Emergency Committee's Log of Bombing Incidents 22-24 December 1940' (hence covering the 'Manchester Blitz' period). This is stated to have been obtained from the Emergency Committee Records/Police Museum and Archives, though it was not possible to obtain the original documents. No references to the site area were found.

11.7. Air Raid Damage Files

Written ARP Incident Records were obtained from The National Archives. This record was compiled by local Air Raid Precaution (ARP) personnel and volunteers during the war and records the location, date and time of bombing raids, as well as the types of bomb used and the damage caused.

This record set was checked, and no references to the site were found within it.

² <https://www.manchestereveningnews.co.uk/news/greater-manchester-news/manchester-blitz-bomb-sites-map-10465447>

11.8. War Damage to Property Cards

These written records were obtained from Manchester Central Library and record the date, type of bomb and detail the level of damage sustained to a property following bombing. A transcript of the relevant written records is presented in the table below. Example imagery of these entries are presented in **Annex K**.

War Damage to Property Cards – Annex K				
Date Range	Location	Description of Property	Type of Bomb	Indication of Extent of Damage
22 nd /23 rd December 1940	Ashton New Road/Crabtree Lane	Baker Co. Ltd. Chemical Works <i>This incident is thought to be the chemical works which occupied the site during wartime.</i>	A.A.	<u>Roof:</u> Slight damage to slats <u>Generally:</u> Glass slight
		L. Greaves & Co. Ltd. Acre Works Factory sheds. Paper finishers <i>This incident is thought to have occurred approximately 100m south-east of the site.</i>	Incendiary.13 8	<u>Roof:</u> All roofs destroyed <u>Walls:</u> Heavy damage to all walls <u>Floors:</u> Heavy damage <u>Generally:</u> Heavy damage to all glass window and doors etc. <u>Damage to contents:</u> All machines and general contents destroyed
		Steel Works- Eva Brothers Ltd. Crabtree Forge, Crabtree Lane, Clayton <i>This incident is thought to have occurred approximately 100m south of the site.</i>	A.A. Incendiary. 135	<u>Roof:</u> Roof lights- slight. Slats-slight. <u>Generally:</u> Glass slight
		Works & stores. Box makers. Vinesta Ltd. <i>This incident is thought to have occurred approximately 190m west of the site.</i>	A.A. Incendiary. 13	<u>Roof:</u> Heavy damage to roof and lights <u>Generally:</u> Heavy damage to glass <u>Damage to contents:</u> Slight damage to general contents

11.9. WWII-Era Aerial Photography

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

WWII-Era Aerial Photography	
Date	Description
16 th May 1948	This aerial photograph of the site is presented in Annex L. This photograph is of low quality and is very grainy. It is of note that the industrial structure on site in this photograph is much larger than is recorded on the bomb/damage map, potentially post-war the structure on site was expanded. According to this photograph, the site was mostly occupied by a large industrial structure, with the remainder of the site occupied by open ground/a storage area, within the east, south and west of the site. Small structures are situated within the north-west of the site. Within the middle of the site is white roofing suggestive of repairs. A small structure within the north-east of the site also has a white roof suggestive of repairs following damage. Lighter roofing is visible to structure within the south of the site. However, due to the quality of the photograph it is not clear whether this is indicative of repairs or the resolution of the photograph. Within the wider area, white roofing is visible to a structure south-east of the site, which correlates with the recorded damage to the <i>Acre Works</i>.

11.10. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an 'abandoned bomb'.

Given the inaccuracy of WWII records, and the fact that these bombs were 'abandoned', their locations cannot be considered definitive or the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

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

11.11. Bomb Disposal Tasks

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

11.12. Evaluation of German Air Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	During WWII, the site was situated within the County Borough of Manchester. According to official Home Office bombing statistics, this borough sustained an overall low density of bombing, with an average of 27.1 items of ordnance recorded per 1,000 acres. Luftwaffe target mapping indicates that the city centre was the focus of bombing, largely due to the presence of the Salford Docks located approximately A single bomb/damage map exists for the district- which focuses on the 'Manchester Blitz' period of the 22nd-24th December 1940 and sporadic incidents on other dates. Seven incendiary bombs are recorded to a structure within the east of the site on the 22nd-24th December 1940. Incendiary bombing is also recorded to the <i>Picture Theatre</i>. Of note incendiary bombing was dropped in 'showers' across the site so it possible that more than the recorded seven incendiary bombs fell onto the site. Incendiary bombing was also recorded in the immediate vicinity- five incendiary bombs were recorded to the <i>Tower Chemical Works</i> on the same date approximately 70m west of the site. South of the site in <i>Clayton Gardens</i>, five incendiary bombs were recorded at <i>Crabtree Forge</i> approximately 100m south of the site on the 22nd-24th December 1940. Additionally, five incendiary bombs were recorded at <i>Acre Works (Packing Materials)</i> approximately 100m south-east of the site. War Damage to Property Cards record incidents which are not recorded on the bomb/damage map. An A.A. projectile is recorded to a Chemical Works on the 22nd/23rd December 1940. This incident is thought to be the chemical works which occupied the site. An A.A projectile and incendiary bombs were recorded to a steel works approximately 100m south of the site. Incendiary bombs were also recorded to <i>Acre Works</i> approximately 100m south-east of the site. Additionally, incendiary bombing was recorded to a cardboard works approximately 190m west of the site.
Damage <i>If buildings or structures on a site sustained bomb or fire damage, any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	The bomb/damage map records a structure within the east of the site as damaged. Damage was also recorded to <i>Acre Works</i> approximately 100m south-east of the site. OS mapping dated 1951-1952 records two structures as <i>Ruins</i>, situated approximately 10m and 25m south of the site respectively. A dashed/broken line is situated within the south of the site potentially indicative of repair works. Furthermore, a large area of clearance is visible approximately 30m west of the site on <i>Crabtree Lane</i> where pre-WWII OS mapping recorded <i>Tower Chemical Works</i>. War damage to property cards records slight damage to the roof and slight glass damage to a chemical works, thought to be situated on site. A number of properties bordering the site are recorded to have sustained damage. Extensive damage is recorded to <i>Acre Works</i> (approximately 100m south of the site) with heavy damage recorded to the roofs, floors, glass windows and contents within the building, following the recorded incendiary bombing. Slight damage is recorded to the roof lights, roof and glass of the steel works situated approximately 100m south of the site. Additionally, extensive damage was recorded to the cardboard works situated 190m west of the site. According to 1948 aerial imagery, white roofing suggestive of repairs is visible to the central section of the site and a structure within the north-east of the site does not show any obvious signs of bomb damage on site, such as ground disturbances/cratering. It should be noted however that this image was taken several years after the main period of bombing in the region and therefore any indications of bombing may have been tended to by the time the image was taken.

Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	As the site is recorded to have been affected by bombing, ground cover is likely to have been unfavourable. Should a UXB have fallen within these areas, it could very easily be obscured by areas of rubble/debris and remain unnoticed and unreported. Furthermore, areas of the site occupied by open ground would not have been conducive to the observation of evidence of UXO. Typically areas of soft, open ground are not conducive to the detection of evidence of UXO as entry holes can be as small as 20cm in diameter.
Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied.</i>	At the outbreak of war it is anticipated access across the site would have been frequent given the heavy industrialised location, and close proximity to roadway. Damage mapping indicates the chemical works which occupied the site was disused. Given the recorded damage to a structure within the east of the site, it is not known the level of access which would have occurred across the site and at which point the chemical works would have been disused from. Additionally, given a number of structures in the immediate vicinity if the site recorded heavy damage it is possible that the bordering industries would have been evacuated until repairs could have taken place.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

12. Introduction to Allied Ordnance

12.1. General

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

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

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas, such as the location of the site, can be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

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

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

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

12.2.1. Anti-Aircraft Artillery (AAA)

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

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

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

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

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

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

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

13.2. Evaluation of Contamination Risk from Allied UXO

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

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1 st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1 st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 2km north-east of the site, in the vicinity of Failsworth. Despite this distance the maximum effective range of an AA projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are generally analogous to those regarding German air delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	Evidence of Home Guard activity is often difficult to locate, owing to the ad-hoc nature of Home Guard activity within each local area. Such training was often conducted on a small scale at the discretion of individual commanders and as such was seldom recorded officially. As such, no positive evidence could be found to confirm the presence of HG units within proximity to the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	There is no evidence of any pillbox, emplacement or other defensive features formerly located on or bordering the site footprint.
Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	No evidence of training or firing ranges could be found within the site or surrounding area.



Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield.

14. The Likelihood of UXO Contamination Summary

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

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre-and post-WWII historical OS mapping, WWI map of air raids and naval bombardments, Luftwaffe target mapping, Manchester bomb and damage map, an interactive 'Christmas Blitz' map, Manchester Emergency Committee's Log of Bombing Incidents, air raid damage files, war damage to property cards and WWII-era aerial photography. The record set is of generally mixed quality, while there are a number of record sets available for consultation, they are not all comprehensive and do not always corroborate with each other. The Manchester bomb and damage map does not appear to plot all incidents and appears to omit A.A. projectiles from the map. However, all consulted records sets indicate the site was not subject to bombing.
German Air Delivered Ordnance	- During WWII, the site was situated within the County Borough of Manchester, which was subject to an overall low density of bombing, culminating in an average of 27.1 items of ordnance per 1,000 acres of land, according to official Home Office bombing statistics. Whilst Manchester did not sustain the intense bombing campaign that other cities such as London and Coventry experienced, the area was still subject to a number of significant targeted bombing raids between 1940 and 1941. Luftwaffe target mapping indicates that the city centre was the focus of bombing, which was situated approximately 4.75km west of the site. - During WWII, the site was occupied by a chemical works and open ground within a heavily industrialised area of Clayton, Manchester. - Manchester bomb and damage map records seven incendiary bombing to a structure within the east of the site on the 22nd/23rd 1940. Incendiary bombing is also recorded to the Picture Theatre which immediately bordered the site to the north. A number of incendiary bombing incidents are recorded within close proximity to the site. This map records a structure within the east of the site as damaged. - War Damage to property cards records an A.A projectile at the on-site chemical works on the same date as the above discussed incendiary bomb. Damage is recorded to the roof and glass of this structure. As this incident is the same date as the recorded incendiary bombing across the site, it is possible the incendiary bombing on site was incorrectly plotted. - Whilst 1948 aerial photography is of low quality, white roofing indicative of repair works is visible across the eastern structure, with cleared ground visible south of the site. The level of repairs/areas of clearance in WWII-era aerial imagery is consistent with post-war OS mapping, which records <i>Ruins</i> which extend south of the site. - It is considered that ground conditions within the areas of damage within the site would have been generally unfavourable to the observation of evidence of UXO. In the recorded areas of damage and the open ground conditions, UXB entry holes, which could have been as small as 20cm in diameter, could easily have been obscured by debris and soft ground. - Following the recorded bomb strikes and damage, access to the site would have partially ceased or reduced altogether. Given the bomb damage map records the chemical works as disused, it is possible the structure on site was abandoned prior to the outbreak of war. In this case, it is not possible to attest how frequent the site would have been accessed. As such, post-raid checks are unlikely to have occurred within abandoned properties.

	• In summary, evidence indicates the site was situated within an industrial area of Manchester which was subject to a number of bombing incidents and damage. There were a number of inconsistencies with the record sets, which suggest further incidents and damage occurred within the immediate vicinity and were not recorded. The Manchester bomb and damage map records incendiary bombing on site, whereas war damage to property cards record an A.A projectile to the chemical works. Given the bomb and damage map is not considered comprehensive, it is possible that additional strikes may have fallen on site and were not recorded. Furthermore, ruins are recorded south of the site which is not recorded on the damage map. • Following the recorded bombing and open areas of the site ground conditions are not considered conducive to the observation of UXB entry holes. Coupled with this, as the chemical works on site was recorded as disused it is not anticipated that post-raid checks to the site would have been frequent. As such, the site has been deemed at Medium Risk.
Allied Ordnance	• There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. • The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding air delivered ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

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

15.2. UXO Clearance

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

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

15.3. Post-War Redevelopment

Post-WWII the composition of the site has mostly remained the same, occupied by an industrial structure and open areas within the east and west of the site.

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

16. The Likelihood of UXO Encounter

16.1. Introduction

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

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

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

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

16.2. Encountering Air Delivered Ordnance

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

17. The Likelihood of UXO Initiation

17.1. Introduction

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

17.2. Initiating Air Delivered Ordnance

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

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

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

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

18. Consequences of Initiation/Encounter

18.1. Introduction

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

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

18.2. Consequences of Detonation

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

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

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

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

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

19.2. Assessed Risk Level

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

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

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

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

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at the Former Walkers Site, Crabtree Lane, Manchester:

Type of Work	Recommended Mitigation Measure
All Works	• UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations	• Unexploded Ordnance (UXO) Specialist Presence on Site to support open excavations When on site the role of the UXO Specialist would include: • Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. • Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. • To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Boreholes/Piles	• Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth: 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

23rd May 2023

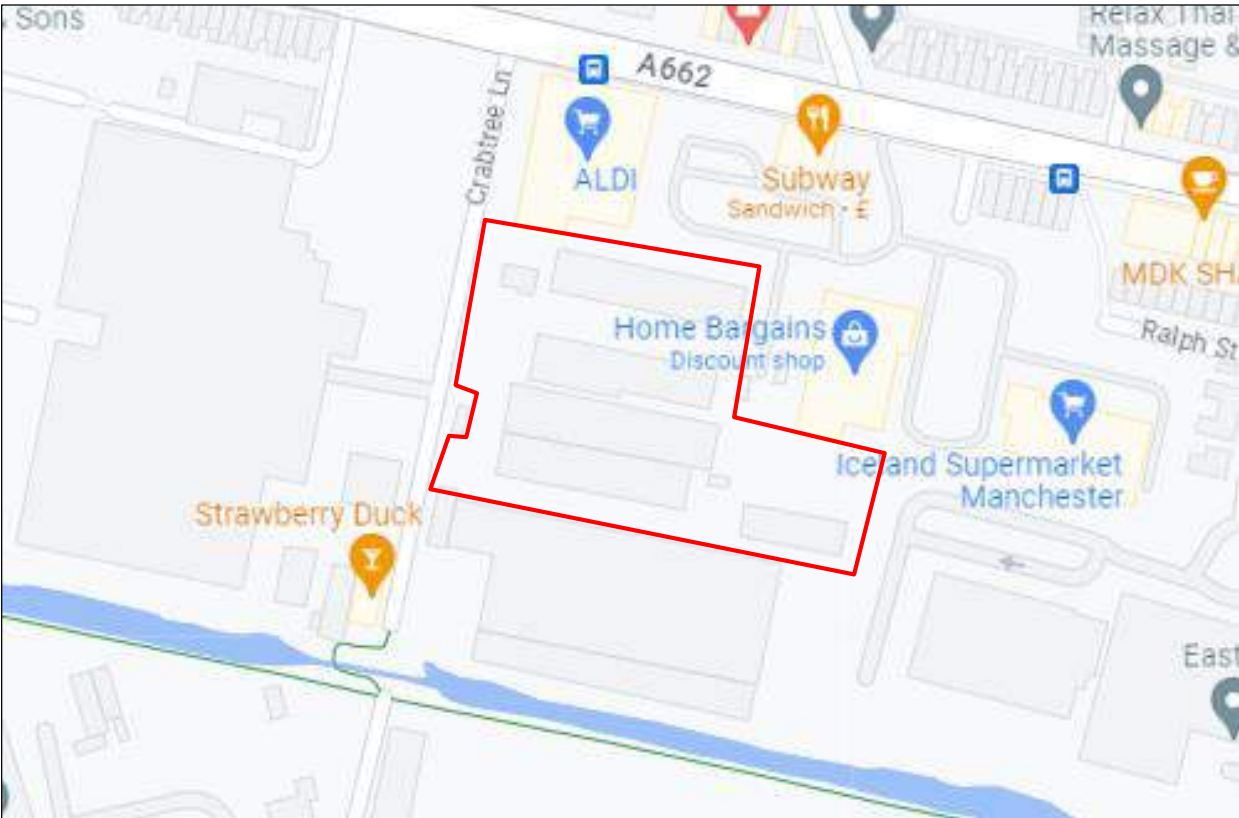
This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: Google Maps

 **Approximate site boundary**





1ST LINE DEFENCE

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

Client: **TRC Companies Ltd.**

— Approximate site boundary

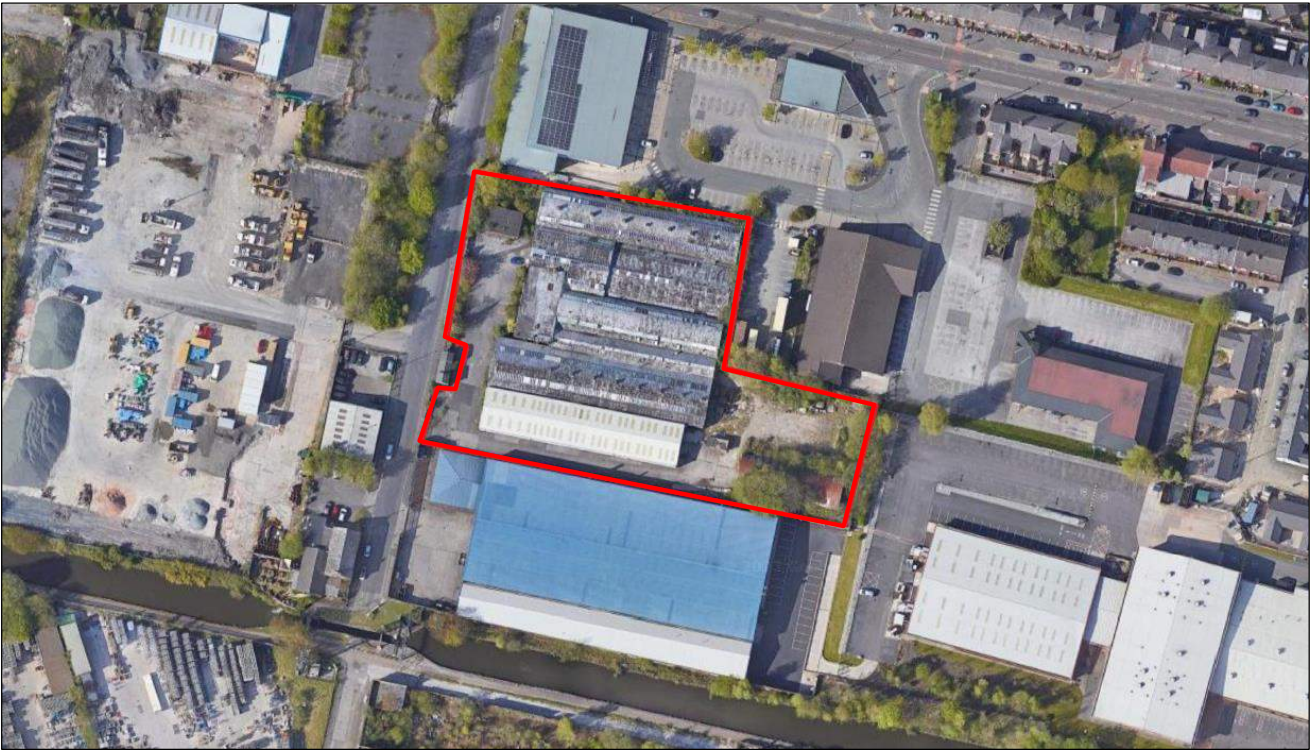
Project: **Former Walkers Site, Crabtree Lane, Manchester**



Ref: **DA17928-00**

Source: Google Earth™ Mapping Services

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Client: **TRC Companies Ltd.**

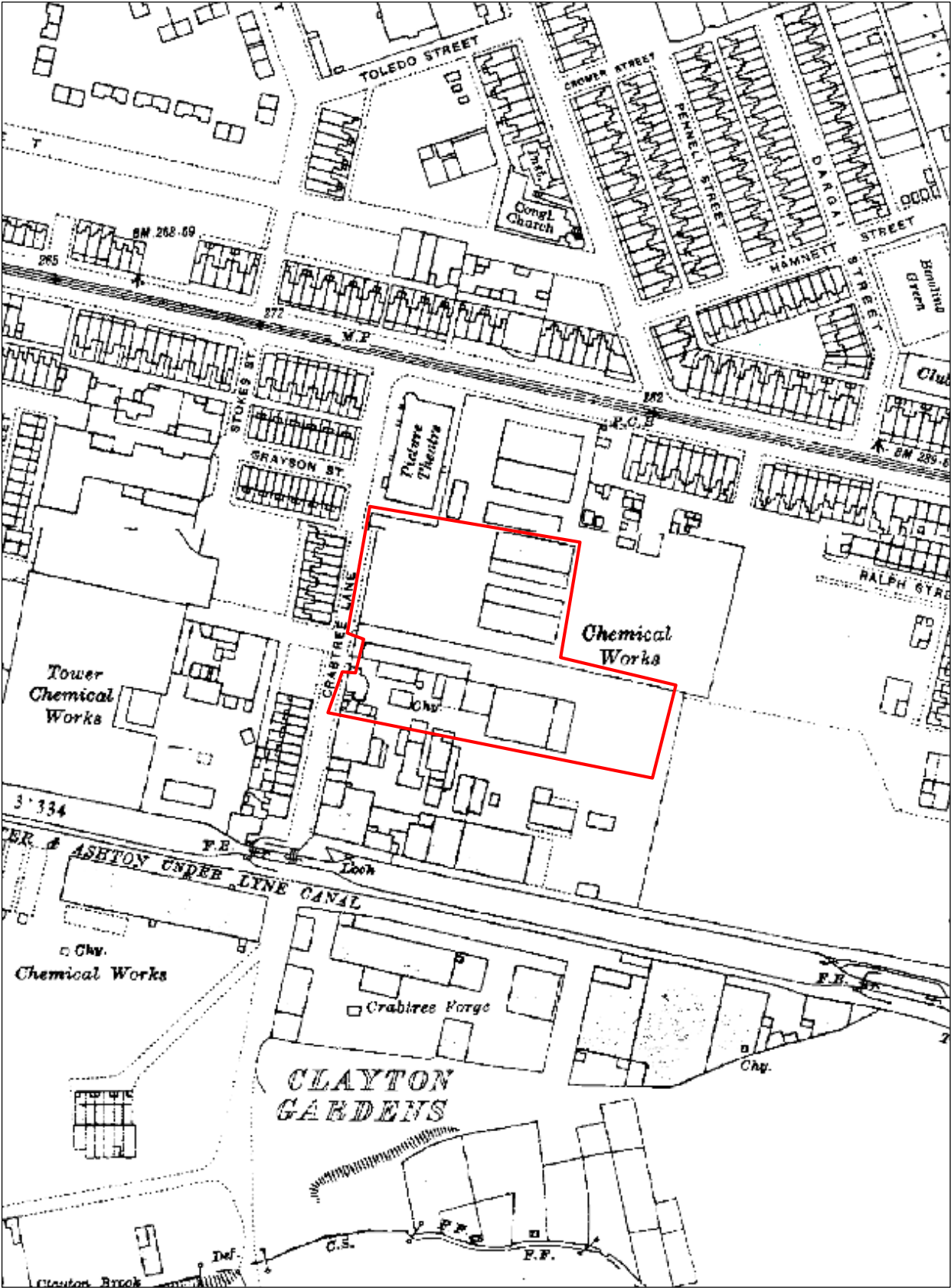
Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: TRC Companies Ltd.

 **Approximate site boundary**





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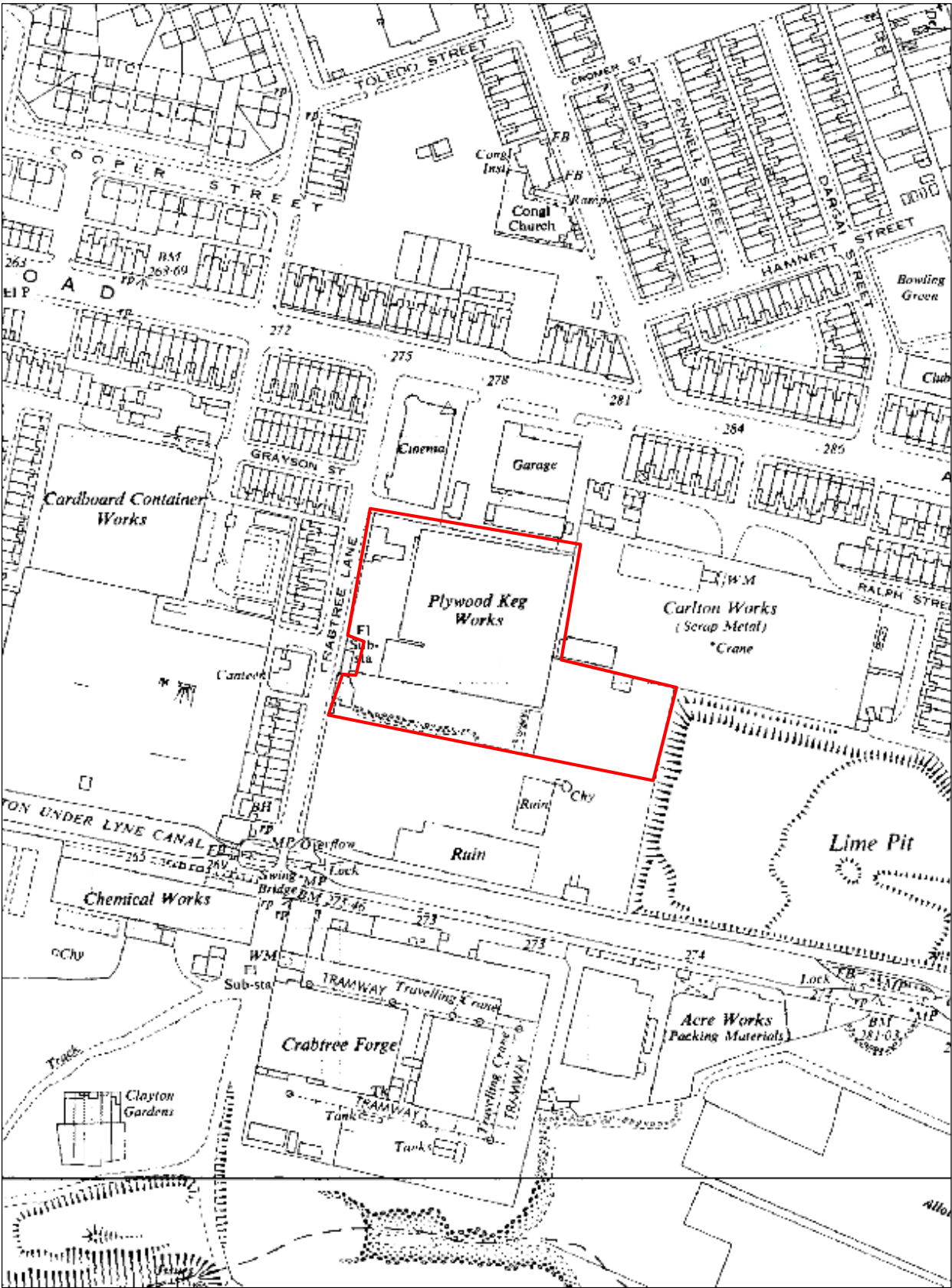
Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: **Landmark Maps**

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Client: **TRC Companies Ltd.**

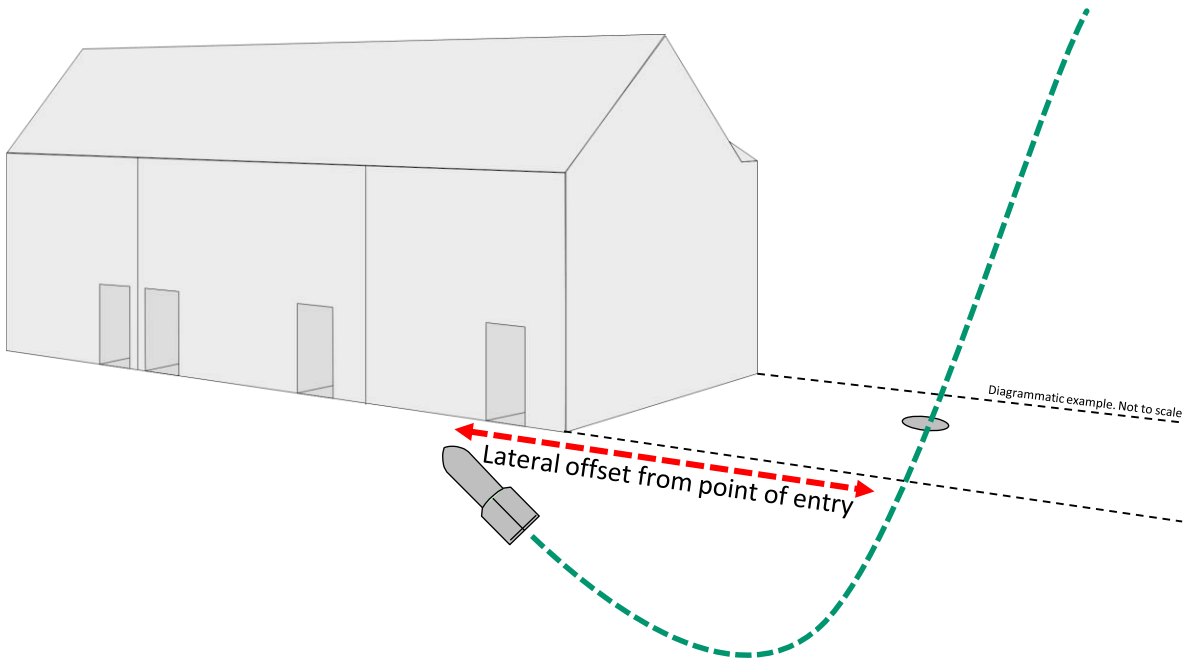
Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: **Landmark Maps**

 **Approximate site boundary**









Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows a 250kg unexploded bomb found in Bermondsey in 2015, pointing upwards, demonstrating ‘J-curve’.



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



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Source: Various sources

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BBCNEWS

Bermondsey bomb: World War Two device safely removed



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

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

Two primary schools were closed and hundreds of homes were evacuated as a precaution.

A cordon and 656ft (200m) exclusion zone was lifted at about 18:15 GMT as the bomb was removed to a quarry in Kent to be detonated, police said.

The Metropolitan Police force said the device was a 'SA' 250kg WWII German air-dropped bomb, known to the Army's Royal Logistic Corps bomb disposal experts.

250kg German HE Bomb, March 2015

BBCNEWS

WW2 bomb found near London City Airport blown up



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

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

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

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

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

500kg German HE Bomb, February 2018

BBCNEWS

Exeter WW2 bomb is detonated after homes evacuated



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

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

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



1000kg German HE bomb, February 2021

BBCNEWS

Great Yarmouth: Huge blast after unplanned WW2 bomb detonation



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

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

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

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

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

250kg German HE Bomb, February 2023

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

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



BASF Provides Some Details

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

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

1st March 2013

SPiegel ONLINE

Blast Kills One
World War II Bomb Explodes on German Motorway

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



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

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

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



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

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

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

19th September 2013



World War II bomb kills three in Germany



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

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

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

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

2nd June 2010



June 2006



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Project:	Former Walkers Site, Crabtree Lane, Manchester		
Ref:	DA17928-00	Source:	Various news sources
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LIVE: Bomb squad in Newton Heath after 'fisherman pulled a bomb out of the canal'

2 OCT 2020



The bomb squad has been called to **Newton Heath** following reports a fisherman pulled a suspected explosive out of the canal.

Surrounding roads have been closed and at least one nearby business is said to have been evacuated.

It's thought the fisherman called police after making the discovery in the Rochdale Canal off Grimshaw Lane at around 8am.

Joan Ward, who runs a food van on nearby Chapter Street, said: "A chap came for a cup of tea and said 'I've just fished a bomb of out the canal so I phoned the police'.

"He's still there now talking to them and the bomb's on the side of the canal.

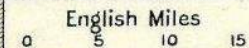
"They've shut all the roads and said they could be closed all day, so we've got to close.

"Budget Greeting Cards on Chapter Street has been evacuated as well.

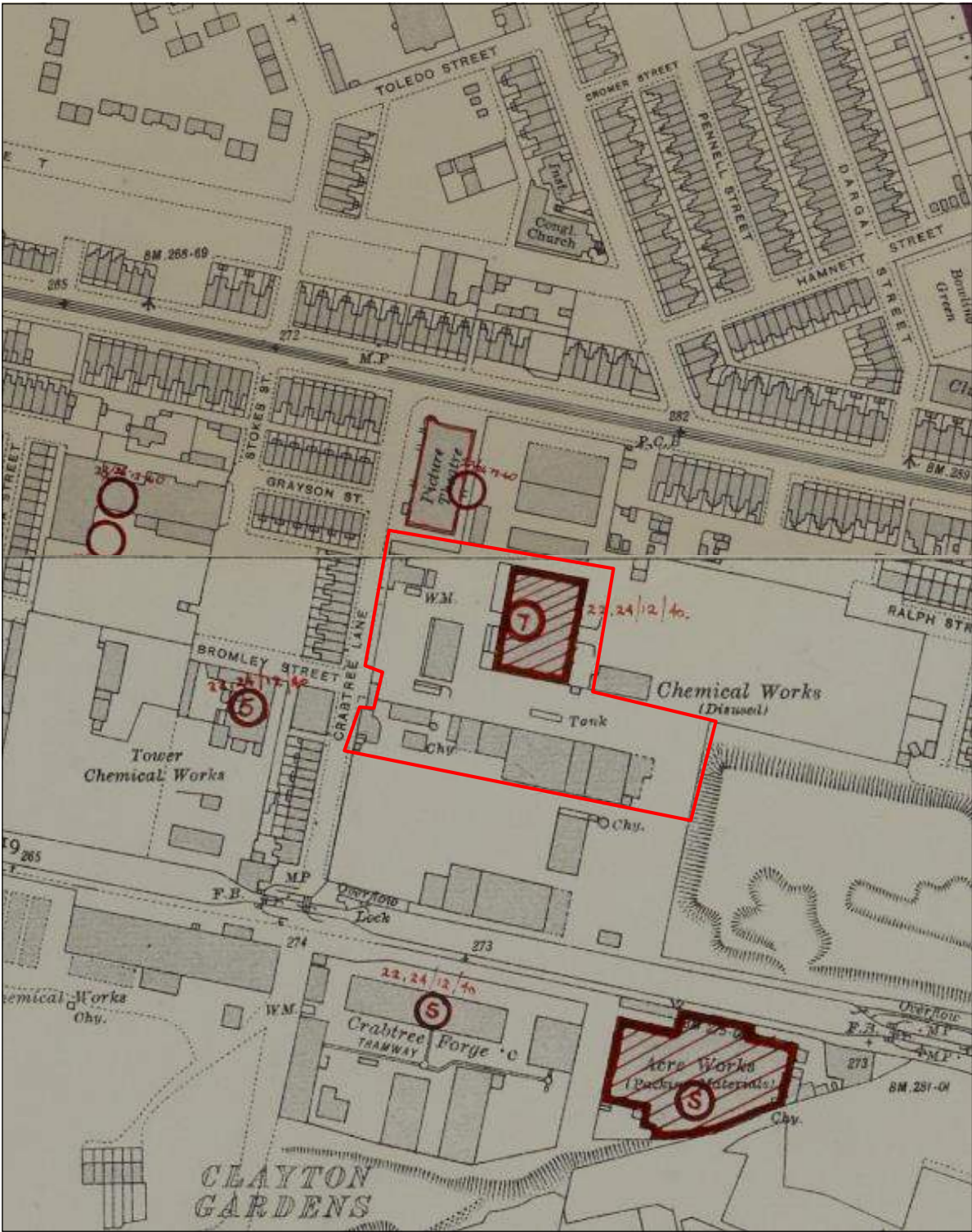
"You can see all the staff standing around outside."

The *M.E.N.* has contacted Greater Manchester Police for a comment.

This incident occurred approximately 2.5km north-west of the site.







 Recorded HE bomb  Recorded incendiary bomb  Damaged building



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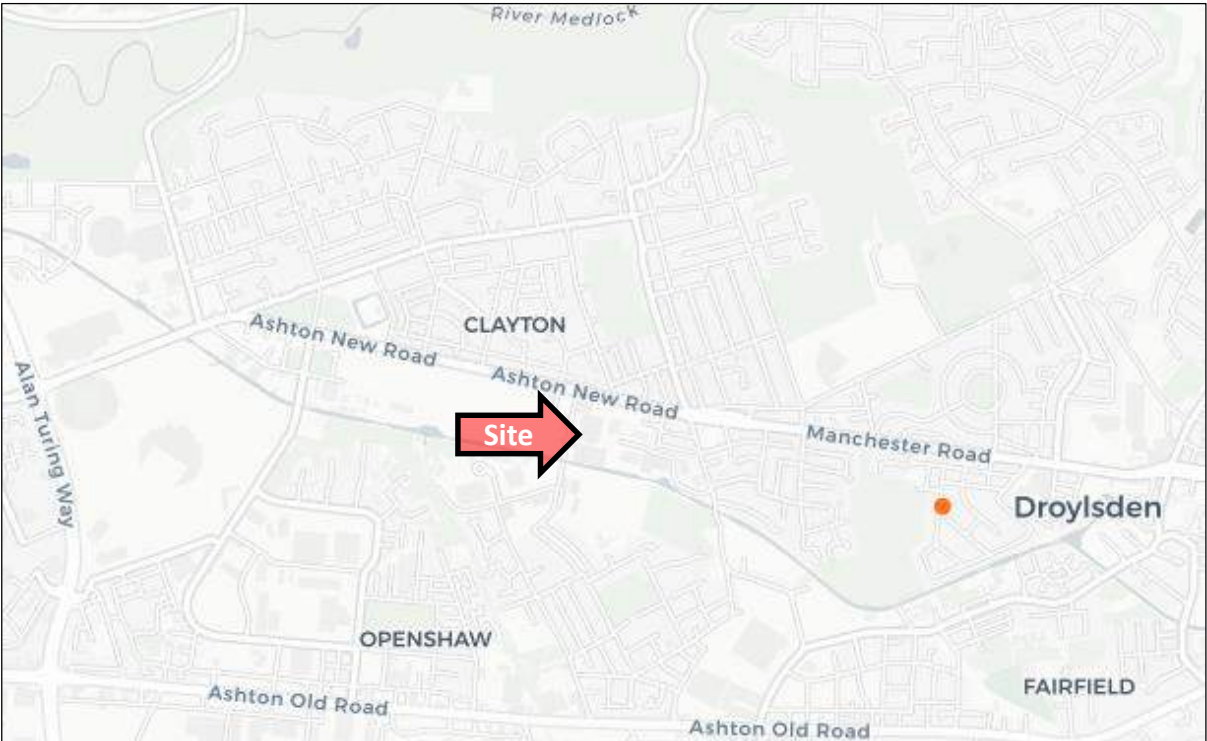
Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: University of Manchester Library

 **Approximate site boundary**





● Fatal bomb incident



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Project: **Former Walkers Site, Crabtree Lane, Manchester**

Ref: **DA17928-00**

Source: Manchester Evening News

— Approximate site boundary



10027 [4578]			CITY OF MANCHESTER CITY ARCHITECT'S DEPARTMENT RETURN OF WAR DAMAGE TO PROPERTY		FOR OFFICE USE ONLY	
LOCATION <i>Orlton New Rd Crabtree Lane</i>		DIST.	DATE <i>22/3/40</i>	PART <i>3</i>	SHEET No <i>569</i>	
			TYPE BOMB <i>A.H.</i>	IF ESSENTIAL BLDG. STATE TYPE		
			GRID No.			
* DESCRIPTION OF PROPERTY <i>Chemical works</i>			FULL ADDRESS AND LOCALITY <i>Baker's Bldg. Crabtree Lane Clayton.</i>			
INDICATION OF EXTENT OF DAMAGE						
ROOF	WALLS	FLOORS		* GENERALLY		
<i>Slight Damage to Slates.</i>	<i>No Damage</i>	<i>No Damage</i>		<i>Glass Slight.</i>		
DAMAGE TO CONTENTS			INDICATION OF DANGEROUS STATE IF ANY			
* TYPE OF DAMAGE <i>D</i>		DATE <i>16/4/41</i>	TIME	INSPECTOR <i>W. H. H.</i>		

10027 [4578]			CITY OF MANCHESTER CITY ARCHITECT'S DEPARTMENT RETURN OF WAR DAMAGE TO PROPERTY		FOR OFFICE USE ONLY	
LOCATION <i>Orlton New Rd Crabtree Lane</i>		DIST.	DATE <i>22/3/40</i>	PART <i>3</i>	SHEET No <i>571</i>	
			TYPE BOMB <i>inc. 13s.</i>	IF ESSENTIAL BLDG. STATE TYPE		
			GRID No. <i>✓</i>			
* DESCRIPTION OF PROPERTY <i>Factory. Sheds. Paper. Finishers</i>			FULL ADDRESS AND LOCALITY <i>F. Greaves & Sons Crabtree Lane Clayton.</i>			
INDICATION OF EXTENT OF DAMAGE						
ROOF	WALLS	FLOORS		* GENERALLY		
<i>all Roofs destroyed.</i>	<i>Heavy Damage to all wall.</i>	<i>Heavy Damage</i>		<i>Heavy damage to all glass window frames and doors etc.</i>		
DAMAGE TO CONTENTS <i>all Machinery and General contents destroyed</i>			INDICATION OF DANGEROUS STATE IF ANY			
* TYPE OF DAMAGE <i>C (B)</i>		DATE <i>16/4/41</i>	TIME	INSPECTOR <i>W. H. H.</i>		



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Project: Former Walkers Site, Crabtree Lane, Manchester

Ref: DA17928-00

Source: Manchester Central Library

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10027 [4578]

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT
RETURN OF WAR DAMAGE TO PROPERTY

FOR OFFICE USE ONLY
PART 3
SHEET No 569

LOCATION
Ordnance Survey RG
Crabtree Lane.

DIST.

DATE 22/8/40
TYPE BOMB A.H.
GRID No. 14C.13.5

IF ESSENTIAL BLDG.
STATE TYPE

* DESCRIPTION OF PROPERTY
Shed works.

FULL ADDRESS AND LOCALITY
Box 13 rather Rd
Crabtree Lane
Clayton.

INDICATION OF EXTENT OF DAMAGE

ROOF
Roof slightly
slight slight

WALLS
No Damage

FLOORS
No Damage

* GENERALLY
Glass
slight

DAMAGE TO CONTENTS

INDICATION OF DANGEROUS STATE IF ANY

* TYPE OF DAMAGE D

DATE 16/4/41

TIME

INSPECTOR W.H. Hap.

10027 [4578]

CITY OF MANCHESTER
CITY ARCHITECT'S DEPARTMENT
RETURN OF WAR DAMAGE TO PROPERTY

FOR OFFICE USE ONLY
PART 3
SHEET No 571

LOCATION
Ordnance Survey RG
Crabtree Lane.

DIST.

DATE 22/8/40
TYPE BOMB A.H.
GRID No. 14C.13.5
✓

IF ESSENTIAL BLDG.
STATE TYPE

* DESCRIPTION OF PROPERTY
works. 2 stores.
boat makers

FULL ADDRESS AND LOCALITY
Vineyard Rd
Crabtree Lane
Clayton.

INDICATION OF EXTENT OF DAMAGE

ROOF
No Damage
to Bell roof
and lights.

WALLS
No Damage

FLOORS
No Damage

* GENERALLY
No Damage
to floors

DAMAGE TO CONTENTS
Slight Damage to
General contents.

INDICATION OF DANGEROUS STATE IF ANY

* TYPE OF DAMAGE C(2)

DATE 16/4/41

TIME

INSPECTOR W.H. Hap.



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 **Approximate site boundary**

Project: **Former Walkers Site, Crabtree Lane, Manchester**



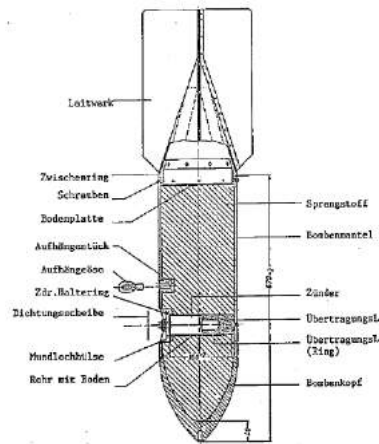
Ref: **DA17928-00**

Source: National Monuments Record Office (Historic England)

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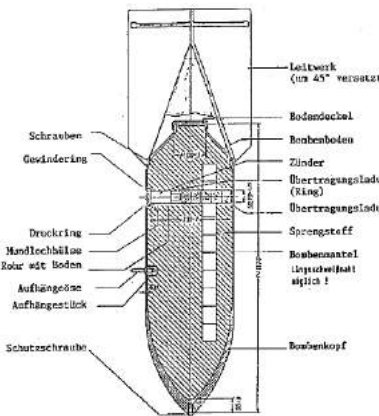
SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



SC 250kg High Explosive Bomb

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

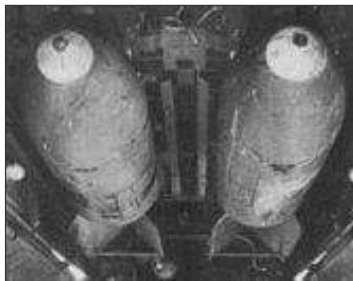
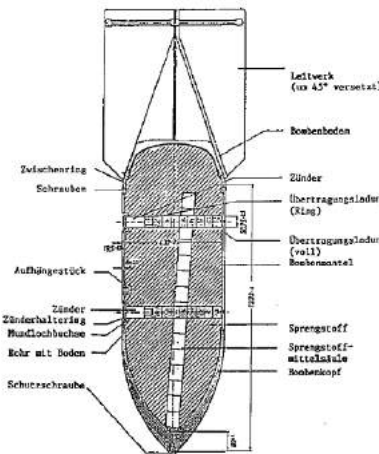


SC250 bomb being loaded onto German bomber



SC 500kg High Explosive Bomb

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



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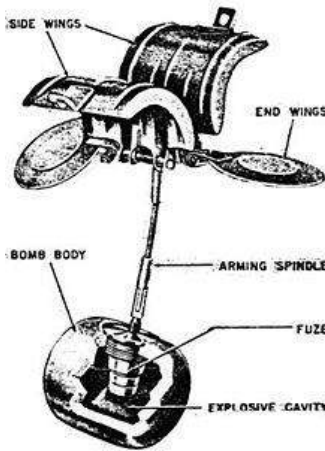
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Source: Various sources

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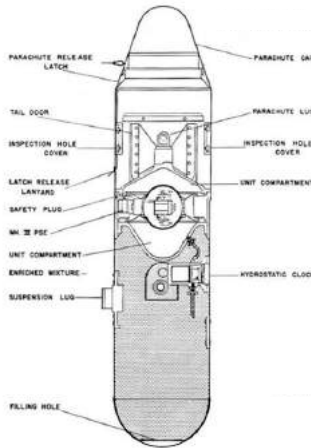
SD2 Anti-Personnel ‘Butterfly Bomb’

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



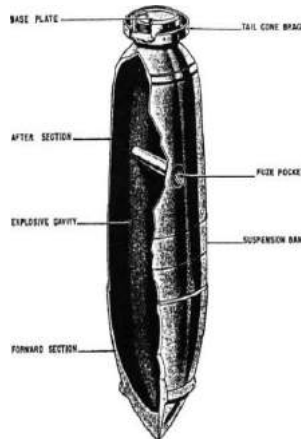
Parachute Mine (Luftmine B / LMB)

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



SC 1000kg

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



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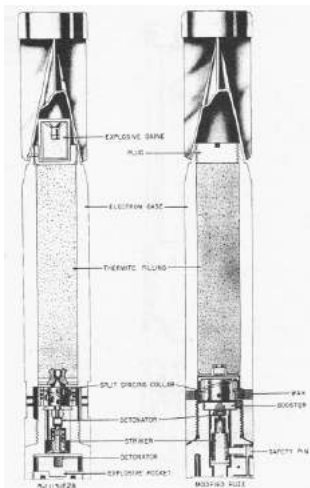
Source: Various sources

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Examples of German Incendiary Bombs

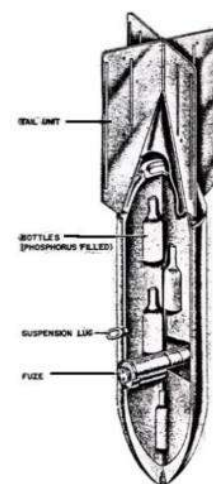
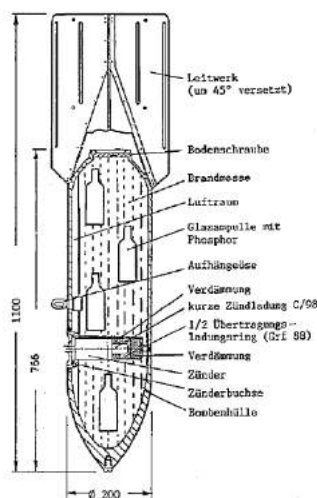
1kg Incendiary Bomb

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



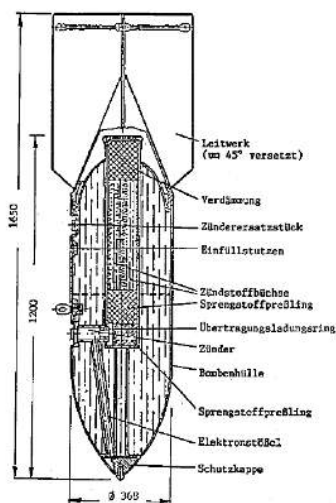
C50 A Incendiary Bomb

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



Flam C-250 Oil Bomb

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



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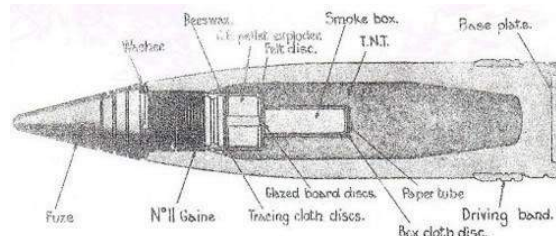
Source: Various sources

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Examples of Anti-Aircraft Projectiles

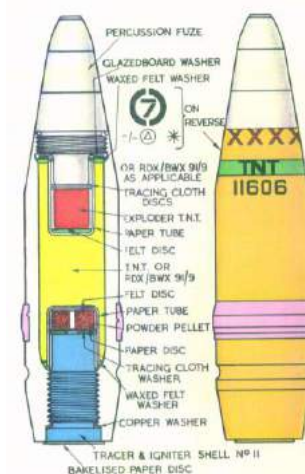
3.7 Inch QF Anti-Aircraft Projectile

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



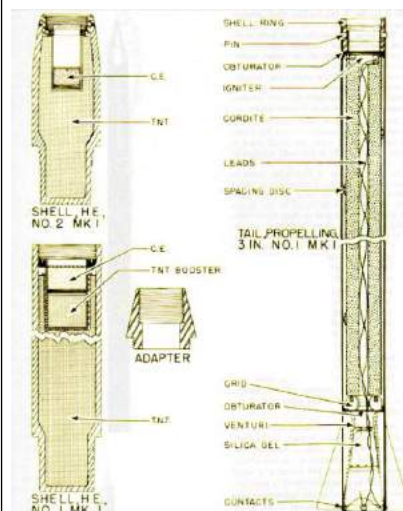
40mm Bofors Projectile

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



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

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



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Source: Various sources

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