



# **Whitefield Fire Station, Whitefield**

## **Phase 1 Geo-Environmental Investigation**

For: Greater Manchester Combined Authority (GMCA)

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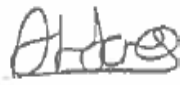
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## REVISIONS

| Revision    | Date                           | Prepared By                                                                                         | Authorised By                                                                                        | Remarks                                              |
|-------------|--------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| First Issue | 11 <sup>th</sup> November 2022 | <br>Angharad Jones | <br>Andrew Edwards | -                                                    |
| Rev A       | 24 <sup>th</sup> February 2023 | <br>Liam McMahon   | <br>Andrew Edwards | Updated CSM based upon further information from GMCA |
|             |                                |                                                                                                     |                                                                                                      |                                                      |



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## 1.0 INTRODUCTION

This Phase 1 Geo-Environmental Investigation report has been prepared at the request of Greater Manchester Combined Authority (GMCA).

Instructions to proceed were received in October 2022. Phase 1 desk study work was undertaken between 31<sup>st</sup> October and 4<sup>th</sup> November 2022.

### Proposed Development

This Phase 1 Geo-Environmental Investigation is to be used for submission to the Local Authority as part of a planning application. It is the Client's intention to demolish the existing fire station and construct a new fire station with associated access road, areas of hard standing and soft landscaping.

A proposed development plan is contained in Appendix 2.

## 1.1 Brief

The brief was to carry out a Phase 1 Geo-Environmental Investigation for the site based upon the proposed development outlined in Section 1.0. The site area is shown on the site location plan contained in Appendix 2.

The investigation was to include the following:

- a) Assess the probable ground conditions and contaminated land conditions on and below the site based on existing and historic site uses and relevant off-site activities, this is to include a site walkover.
- b) Identify probable contaminants / sources of contamination that may be present at the site using current contaminated land guidance and develop a conceptual site model for potential human health, ground gas and controlled waters receptors.

- c) Undertake a Preliminary Risk Assessment – which will determine the requirement for further environmental (contaminated land) investigation and assessment.
- d) Design on the basis of the anticipated ground conditions appropriate ground investigation works and discuss potential development issues (i.e. sub-surface features – obstructions, infilling, compressible ground, faulting, mineral extraction, mining and land instability).

A summary of the information / data sources is detailed in Section 2.2. A report was to be provided to summarise findings and to provide recommendations.

The limitations of this investigation work and report are included in Appendix 1.

## **1.2 Third Parties**

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## **2.0 SCOPE OF INVESTIGATION WORKS**

### **2.1 Walkover Survey**

The site was visited on 31<sup>st</sup> October 2022 in overcast weather conditions and the objectives of the site walkover were, where applicable:

- to identify and assess visual and olfactory evidence of contamination (e.g. staining of concrete / soils, odours, presence of gas protection measures etc.);
- to identify locations of potential sources of contamination and assess their conditions (i.e. tank location, presence / condition of secondary containment / bunds, location of fill points, process areas);
- to identify surrounding land uses and any potentially contaminating activities;
- to identify / verify the presence of potential receptors (on- and off-site) which may be affected by identified sources;
- to obtain information on activities / procedures and standards of housekeeping etc.;
- to assess site access and potential investigation locations and constraints; and
- to assess any visual subsurface geotechnical features / anomalies (e.g. foundations, Made Ground, subsidence etc.).

Photographs were taken of the site during the walkover survey and these photographs, together with a plan indicating their location and direction, are contained in Appendix 3.

### **2.2 Documentation**

The following documents were obtained and examined during the desk study:

- a) A combined Enviro + Geo Insight report was obtained from Groundsure, an environmental database company, which provides a list of recorded past and present activities at or adjacent to the site which could have an impact on the levels of contamination in the soils and groundwater at the site. The report is contained in Appendix 5.

- b) Aerial photographs of the site dated: May 2019, June 2015, May 2011 and June 2000. The photographs are contained within the Groundsure Enviro + Geo Insight report in Appendix 5.
- c) Historical Ordnance Survey maps dated between 1850 and 2022, at scales of 1:1,250, 1:2,500, 1:10,000 and 1:10,560.
- d) Groundsure maps, all dated 2022, as follows:
- Historical Land Use map;
  - Environmental Permits, Incidents and Registers map;
  - Landfill and other Waste Sites map;
  - Current Land Use map;
  - Hydrogeology and Hydrology maps;
  - Environment Agency / Natural Resources Wales flood maps;
  - Designated Environmentally Sensitive Sites map;
  - Geological maps and Ground Working map;
  - Mining, Extraction & Natural Cavities map;
  - Natural Ground Subsidence maps;
  - Borehole Records map;
  - Railways and Tunnels map.

These maps are contained within the Enviro + Geo Insight report in Appendix 5.

- e) The following sources were obtained and examined from the British Geological survey. All items were copied under licence; [C18/01] British Geological Survey ©UKRI. All rights reserved:
- The British Geological Survey (BGS) 1:50,000 solid and drift geological maps (Sheet 85, dated 2010 and 2011).
  - 2 No. BGS Borehole logs were also obtained (Ref: SD80NW388 and SD80NW7).
- f) A Zetica UXO Risk Map is included in Appendix 7.A Preliminary UXO Risk Assessment Report was obtained which is also included in Appendix 7.

## 3.0 FINDINGS

### 3.1 Site Location and Description

This report pertains to a c. 0.35 Ha site located to the east of Bury New Road, Whitefield, at the postcode M45 7SY. The National Ordnance Survey Grid Reference for the centre of the site is 380477E, 406478N.

The site currently comprises a single-storey masonry fire station building with associated 5-storey training tower, areas of hardstanding in the northern site section and soft landscaping in the southern site section. The site is bound by residential dwellings to the north and east, Total Fitness Whitefield to the south and Bury New Road to the west. Access to the site is off Bury New Road along the western boundary of the site. An aerial photo of the site is included below:



*Figure 1: Aerial image of the site dated May 2019.*

### 3.2 Walkover Survey

The walkover survey was carried out on 28<sup>th</sup> October 2022 during overcast weather conditions. During the walkover survey the following features were noted.

The site currently comprises an active single storey masonry fire station with associated access road, car parking, training tower and training area and areas of soft landscaping. The ground underfoot was noted to comprise hardstanding (concrete and macadam) across the majority of the site, with the exception of the south western site section which was noted to be grass.



Figure 2: Photographs of the rear and front of the fire station

The topography of the site was noted to be generally flat, with the ground sloping very gently from c. 104m AOD in the south western corner of the site to c. 103m AOD in the north west and c. 102.50m AOD in the eastern corner of the site. A retaining wall was noted along the majority of the northern boundary of the site, retaining c. 0.50m - 1.00m bgl on-site. Numerous manholes were noted across the site including

telecommunications, water and gas. Established trees were also noted along the site boundaries and in the south western site section.



Figure 3: Photograph of the retaining wall (left) and service manholes (right)

### Contamination

Possible contaminative sources were identified during the site walkover, including a disused diesel pump and suspected associated underground storage tank, drums of AdBlue and a hydrocarbon spirit storage room in the north eastern corner of the site. A suspected interceptor was recorded adjacent the aforementioned features. No information was available regarding the size of the tank or whether it has been decommissioned.



Figure 4: Photographs of the diesel pump, AdBlue, petroleum spirit storage and interceptor

A boiler room was also noted in the main building in the central site section. Disused vehicles used for training were also noted in the eastern site section which are considered a potentially contaminative source.



Figure 5: Photographs of the vehicles and boiler room

### 3.3 Site History

The site development history has been researched by reference to historical maps, street plans and aerial photographs. The historical maps are included in Appendix 4 to this report and the principal observations which are divided into on-site history and off-site history are summarised below:

#### On-Site History

| Date        | Site Feature                                                                                                                                                                                                                                                             |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1850 - 1909 | On the earliest historical map (dated 1850) a row of terraced dwellings are present along the western boundary. The majority of the site appears to be open land.                                                                                                        |
| 1909 - 1955 | By 1909, the eastern site section appears to have been divided into numerous parcels of land with small buildings of unknown use.                                                                                                                                        |
| 1955 -1963  | By 1955, the majority of the terraced dwellings along the western boundary have been demolished. 2 No. glasshouses are recorded in the eastern site section associated with Allotment Gardens recorded to the east of the site, extending into the eastern site section. |
| 1963 - 2022 | By 1963 the existing fire station is recorded on-site. The site has remained relatively unchanged since.                                                                                                                                                                 |

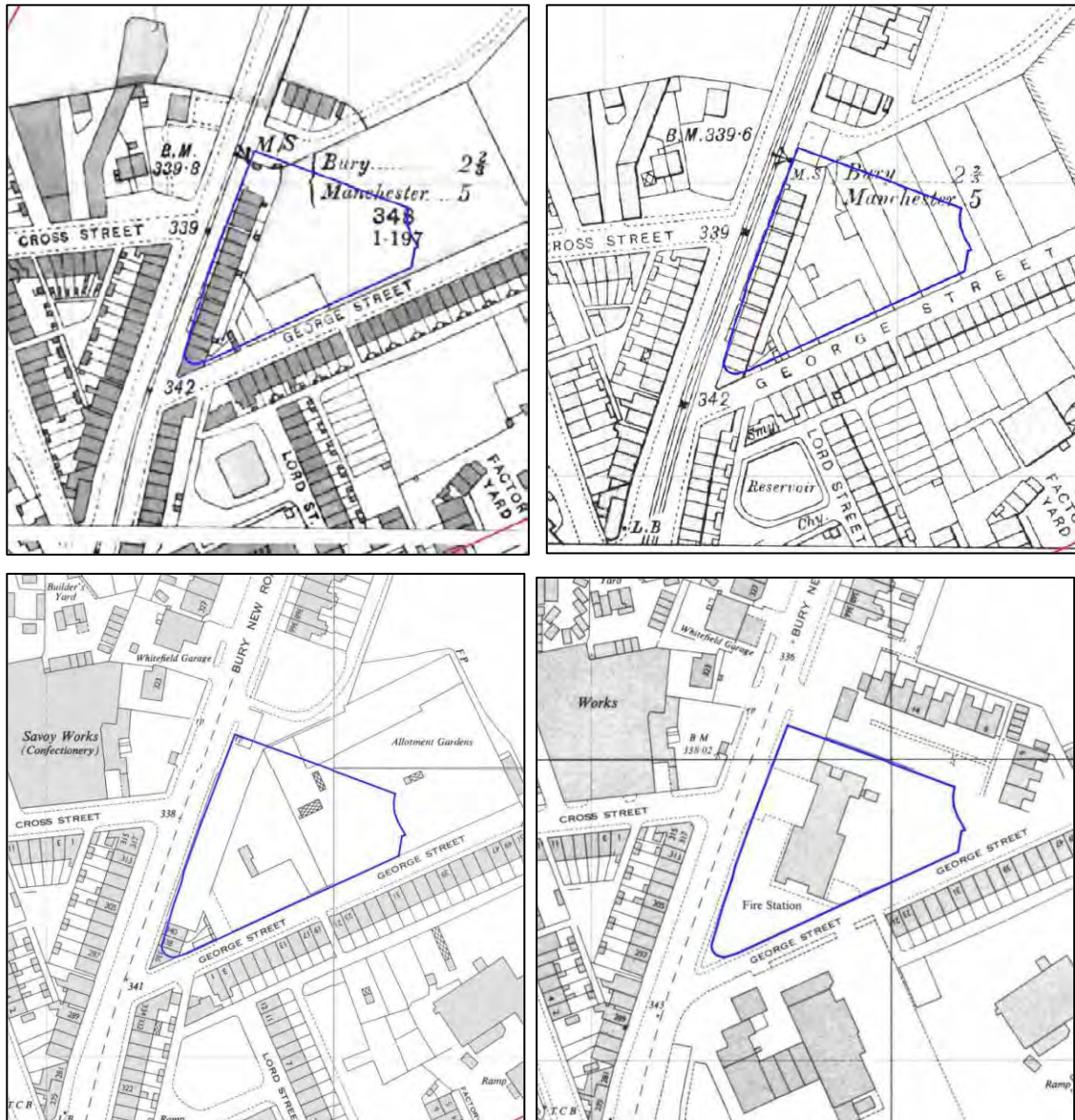


Figure 6: Extracts of the OS historical maps dated 1893,1909, 1955 and 1970 from left to right, top to bottom

A historical aerial image showing the site has been obtained from Britain From Above dated 1951 which is included below:



Figure 7: Historical aerial image of the site dated 1951

### Off Site History

| Dates       | Site Feature                                                                                                                                                                                                                                                                                 | Distance (m) | Direction |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| 1893 - 1963 | New Mill (Cotton) is recorded c. 60m south of the site with associated reservoir. Recorded as a Cabinet Marking Mill from 1955 and the reservoir appears to have been infilled. The mill is no longer recorded by 1963.                                                                      | 60           | S         |
| 1893 - 1982 | Whitefield Mill (Cotton) with associated Reservoir, Tanks, Gasometer and Yard is recorded c. 50m south east of the site. Recorded as an Upholstery Mill from 1955 and the tanks have been removed, the reservoir remains. The Mill is no longer recorded by 1982 and the reservoir infilled. | 40           | SE        |
| 1893 - 1932 | A smithy is recorded to the south of the site on the 1893 maps, the smithy is no longer recorded by 1932.                                                                                                                                                                                    | 20           | S         |
| 1893 - 1973 | Stanley Mill (Cotton) is recorded to the south east of the site on the 1893 historical map, the mill is recorded as a confectionary mill from 1909 and is no longer recorded by 1973.                                                                                                        | 230          | SE        |
| 1893 - 1922 | Eagle Paint Mill is recorded to the south of the site on the 1893 historical map. The mill is recorded as Victoria Engineering Works by 1909 and is no longer recorded from 1922.                                                                                                            | 260          | S         |
| 1955 - 1981 | Savoy Works (Confectionary) is recorded to the west of the site by 1955 and is no longer recorded by the 1981.                                                                                                                                                                               | 40           | W         |

### 3.4 Geology

#### 3.4.1 BGS Geological Map

The BGS 1:50,000 Solid and Drift Geological Maps of the area (Sheet No: 85, Dated: 2010 and 2011 respectively) indicate that the majority of the site is underlain by superficial deposits comprising **Glacial Till** which typically comprises a heterogenous mixture of clays, sands and gravels. The eastern site section is underlain by superficial deposits comprising **Glaciofluvial Deposits** which typically comprise sand and gravels.

The superficial deposits are underlain by variable bedrock. The northern site section is underlain by the **Collyhurst Sandstone Formation** comprising sandstone, whereas the southern site section is underlain by **Manchester Marls Formation** comprising mudstone.



Figure 8: Extracts of the BGS 1:50,000 Drift (left) and Solid (right) Geological Maps. Light blue = Glacial Till, Pink = Glaciofluvial Deposits. Light Orange = Collyhurst Sandstone Formation, Dark Orange = Manchester Marls Formation

The solid geological map indicates that a fault is recorded to cross the central site section which downthrows to the south.

### 3.4.2 BGS Borehole Logs

There are no available BGS boreholes on-site. There are 2 No. BGS boreholes available in close proximity to the site within a comparable geological setting. The pertinent information from the borehole logs is outlined below:

#### BGS Borehole Reference: SDNW388

This borehole is located approximately c. 40m south east of the site and was progressed to a depth of 182m bgl in 2002. The log recorded the following pertinent information:

- **Concrete** to a depth of 0.50m bgl, underlain by;
- **Made Ground** to a depth of 2.70m bgl, underlain by;
- **Sands and Clay** bands to a depth of 57.00m bgl, underlain by;
- Red **Marl** and **Sandstone** to a depth of 70.00m bgl, underlain by;
- Red and grey **Marl** to a depth of 163.50m bgl, underlain by
- Red and grey **Sandstone** to a depth of 182.00m bgl.

Groundwater was encountered at c. 42m bgl.

#### BGS Borehole Reference: SD71NE7

This borehole is located approximately c. 70m south east of the site and was drilled to a depth of 152.70m bgl in 1933. The log recorded the following pertinent information:

- **Well** to a depth of 9.14m bgl, underlain by;
- **Clay** to a depth of 15.15m bgl, underlain by;
- **Sand** to a depth of 18.29m bgl, underlain by;
- **Clay** to a depth of 26.52m bgl, underlain by;
- **Sandy Clay** to a depth of 41.76m bgl, underlain by;
- Brown **Clay** to a depth of 57.91m bgl, underlain by;
- Grey **Rock** to a depth of 62.18m bgl, underlain by;
- Red **Marls and Sandstone** to a depth of 152.70m bgl

### 3.4.3 BGS Geohazards

| Data Type             | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ground Stability Data | <ul style="list-style-type: none"> <li>➤ The Potential for Shrinking or Swelling Clay Ground Stability Hazards is regarded as negligible to very low.</li> <li>➤ The Potential for Landslide Ground Stability Hazards is regarded as very low.</li> <li>➤ The Potential for Dissolution Ground Stability Hazards is regarded as negligible.</li> <li>➤ The Potential for Compressible Ground Stability Hazards is regarded as negligible.</li> <li>➤ The Potential for Collapsible Ground Stability Hazards is regarded as very low.</li> <li>➤ The Potential for Running Sand Ground Stability Hazards is regarded as very low.</li> </ul> |

### 3.4.4 BGS Estimated Soil Chemistry

The BGS have estimated that the superficial deposits across the site to naturally comprise the following determinands:

- Arsenic – 15mg/kg - 25mg/kg
- Cadmium – 1.8mg/kg
- Chromium – 40mg/kg – 60mg/kg
- Nickel – 15mg/kg – 30mg/kg
- Lead – 100mg/kg - 300mg/kg
- Bioaccessible Lead – 60mg/kg - 240mg/kg

## 3.5 Mining

### 3.5.1 Coal Mining

The site lies within a Coal Authority Coal Mining Reporting Area, however, no coal outcrops, mine entries or associated development high risk areas are recorded on-site. No recorded or probable shallow workings or underground workings are recorded on-site.

### 3.5.2 Non-Coal Mining

The Groundsure Enviro + Geo Insight report (contained in Appendix 5) indicates that no non-coal mining has occurred on-site or in close proximity to the site.

### 3.5.3 Salt Mining / Brine Extraction

The site lies within the Cheshire Brine Subsidence Compensation Board Compensation District but not within a Consultation Area.

### 3.5.4 Historical Surface Excavations

Although no historical excavations or ponds are recorded on-site on the historical maps, given the presence of open land and allotment gardens historically on-site, the presence of unrecorded historical excavations on-site cannot be discounted.

### 3.5.5 Mineral Safeguarding

Where mineral resources are present the mineral planning authority may designate areas as Mineral Safeguarding Areas (MSA) and Mineral Consultation Areas (MCA). These are aimed to safeguard mineral resource areas from unnecessary sterilization by non-mineral development. The BGS Mineral Resources maps designate the areas of potential mineral resources and where active / lapsed planning permission was granted for mineral extraction.

The BGS Mineral Resources Map for Greater Manchester indicates that Glaciofluvial Deposits resources lie in the south eastern site section and shallow clay and / or brick clay resources exist across the remainder of the site. However, no mineral planning permissions or mineral workings exist on-site.

The Greater Manchester joint mineral plan mineral resource maps indicate that mineral safeguarding area for sand and gravel, brick clay and coal. The proposed development is not considered likely to sterilise the minerals as the site has been developed since the mid 19<sup>th</sup> Century. Additionally, the glaciofluvial deposits on-site are limited to a very small area in the eastern site section and the Glacial Till is also anticipated to contain a significant proportion of sand and gravel, therefore would not be economical to extract. Bedrock is anticipated to be at significant depth beneath the site (c. 57m bgl) therefore mining of coal from surface is not feasible.

The BGS mineral resource map for Greater Manchester and the Greater Manchester joint minerals plan mineral safeguarding maps are contained in Appendix 6.

### 3.6 Previous Site Investigations

No available previous site investigations are located on-site or in close proximity to the site.

### 3.7 Hydrology and Hydrogeology

Environmental data relevant to the site and its immediately surrounding area has been obtained from sources available in the public domain. In addition, an environmental report was obtained from Groundsure. The Enviro + Geo Insight report and associated maps that have been inspected are presented in Appendix 5 and the principal observations in relation to waters and flooding can be summarised as follows:

| Data Type                   | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flooding                    | <ul style="list-style-type: none"> <li>➤ With respect to rivers and seas, the site lies within Flood Zone 1.</li> <li>➤ The site is not at significant risk of surface water flooding, the highest risk is associated with a 1 in 1000 year even with a floodwater depth of between 0.10m and 0.30m.</li> <li>➤ A BGS groundwater flooding susceptibility area has also been identified on-site, however, the risk is deemed to be Low across most of the site, with an area of moderate risk in the eastern site section associated with the Glaciofluvial Deposits.</li> </ul> |
| Surface Water Features      | <ul style="list-style-type: none"> <li>➤ No surface water features are recorded on-site or within 500m of the site.</li> <li>➤ The nearest surface water feature is the River Irwell located c. 710m north west of the site.</li> </ul>                                                                                                                                                                                                                                                                                                                                          |
| Surface Water Abstractions  | <ul style="list-style-type: none"> <li>➤ There are no licensed surface water abstractions located on-site.</li> <li>➤ There are 3 No. licensed surface water abstractions located within 2km of the site, all of which are historical licenses. The nearest was located 1141m east and pertained to the abstraction of water from Whitefield Brook for process water.</li> </ul>                                                                                                                                                                                                 |
| Superficial Aquifer         | <ul style="list-style-type: none"> <li>➤ The majority of the site is underlain by superficial deposits comprising Glacial Till classified as a Secondary Undifferentiated Aquifer.</li> <li>➤ A small area in the Eastern Site Section is underlain by Glaciofluvial Deposits classified as a Secondary A Aquifer - <i>Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.</i></li> </ul>                                                                        |
| Bedrock Aquifer             | <ul style="list-style-type: none"> <li>➤ The underlying bedrock across the majority of the site is classified as a Principal Aquifer - <i>layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale</i></li> </ul>                                                                                                                                                                                      |
| Groundwater Abstractions    | <ul style="list-style-type: none"> <li>➤ There are no recorded groundwater abstraction licenses located on-site.</li> <li>➤ There are 19 No. groundwater abstraction licenses located within 2km of the site, the majority are historical. The nearest active groundwater abstraction is located 413m south east of the site and pertains to the abstraction of groundwater from a borehole off Stanley Road for process water.</li> </ul>                                                                                                                                       |
| Source Protection Zones     | <ul style="list-style-type: none"> <li>➤ There are no recorded Source Protection Zones recorded on-site or within 500m of the site.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Nitrate Vulnerable Zones    | <ul style="list-style-type: none"> <li>➤ There are no Nitrate Vulnerable Zones recorded on-site or within 500m of the site.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Licensed Discharge Consents | <ul style="list-style-type: none"> <li>➤ There are no recorded licensed discharge consents to controlled waters located on-site or within 500m of the site.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                           |

|                                          |                                                                                                              |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Pollution Incidents to Controlled Waters | ➤ There are no recorded pollution incidents to controlled waters located on-site or within 500m of the site. |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------|

### 3.8 Hazardous Installations, Landfill and Waste

The following information relating to hazardous installations, landfill and waste obtained from the Groundsure Enviro + Geo Insight report, published information and the walkover survey can be summarised as follows:

| Data Type                                                                                           | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment Agency Recorded Active Landfill Sites                                                   | ➤ There are no Environment Agency recorded landfill sites located on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Environment Agency Recorded Historic Landfill Sites                                                 | <ul style="list-style-type: none"> <li>➤ There are no Environment Agency recorded historical landfill sites located on-site.</li> <li>➤ There is a single Environmental Agency recorded historical landfill site within 500m of the site, located 361m north west of the site off Theodore Street. No information pertaining to the landfill operation dates or type of waste is available for this landfill.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| BGS Recorded Historic Landfill Sites                                                                | ➤ There are no BGS recorded landfill sites located on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Local Authority Recorded Landfill Sites                                                             | ➤ There are no Local Authority recorded landfill sites located on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Local Authority Pollution Prevention and Control (Part A(2) and Part B Activities and Enforcements) | <ul style="list-style-type: none"> <li>➤ There are no Local Authority Part A2 or Part B Activities or Enforcements located on-site.</li> <li>➤ There are 2 No. Local Authority Part A2 or Part B Activity located within 500m of the site. Both are current, with the nearest being located 35m north west of the site and pertaining to the unloading of petrol into storage at a service station.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Registered Radioactive Substances                                                                   | ➤ There are no Registered Radioactive Substances recorded on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Registered Waste Treatment, Transfer or Disposal Sites                                              | ➤ There are no licensed waste sites located on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Industrial Land Use                                                                                 | <ul style="list-style-type: none"> <li>➤ There are 2 No. current industrial land uses recorded on-site, including telecommunications features and the fire station itself.</li> <li>➤ There are an additional 8 No. recent industrial uses recorded within 500m of the site, the nearest is located 36m east and pertains to an electricity sub-station. The remainder include a petrol and fuel station and a vehicle repair and servicing site.</li> <li>➤ There is a single petrol / fuel station recorded within 500m of the site, located 23m north west of the site.</li> <li>➤ There is a single historical industrial site use recorded on-site. This is the subject fire station.</li> <li>➤ There are an additional 90 No. historic industrial land-uses recorded within 500m of the site, including unspecified mills, unspecified works, unspecified tanks, cotton mills, police station, cuttings, tunnels, dye works and more.</li> </ul> |
| Dangerous Substances                                                                                | ➤ There are no recorded discharges of dangerous substances on-site or within 500m of the site.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Hazardous Building Materials                                                                        | ➤ Given the age of the existing building, asbestos containing materials may be present.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

### 3.9 Radon

The Indicative Atlas of Radon in England and Wales produced by the Health Protection Agency and British Geological Survey indicates the site lies within a lower probability area as between 1% and 3% of homes are above the action level. Consequently, BR211 (2015) indicates that no radon protection measures are required.

### 3.10 Services

The site is an active fire station and numerous manholes and evidence of services were noted across the site, therefore full service plans should be obtained prior to any intrusive works.

### 3.11 Unexploded Ordnance (UXO)

The Zetica UXO risk map, contained in Appendix 7, indicates that the site lies within an area of low risk. A preliminary UXO risk assessment report was obtained which concluded that a Stage 2 Detailed Risk Assessment is not considered necessary prior to works commencing. However, the possibility of UXO remaining on site cannot be completely ruled out at desktop stage. Therefore, a UXO Safety Awareness Briefing to all personnel conducting ground works would be considered prudent.

The Zetica UXO Risk map and preliminary UXO risk assessment report are included within Appendix 7.

### 3.12 Animal Burial Sites

The Animal Health and Veterinary Laboratories Agency (AHVLA) no longer routinely respond to consultations relating to records of animal burial sites. Based upon a review of the site history it is considered unlikely that the site has been subject to recorded animal burials.

### **3.13 Archaeology**

We do not anticipate that the site will be affected by archaeological issues, however consultation with the county archaeologist is recommended.

## 4.0 CONCLUSIONS

### 4.1 General

Residential dwellings and allotment gardens were present on-site until the existing fire station was constructed in the 1960s. The site has remained relatively unchanged since.

### 4.2 Ground Conditions

The anticipated typical ground conditions across the site are as follows:

- **Made Ground** of unknown composition to an unknown depth, possibly deep in the vicinity of the suspected underground tank, underlain by:
- [Eastern site section only] **Glaciofluvial Deposits** comprising SAND and GRAVEL to an unknown depth, underlain by:
- **Glacial Till** comprising firm to stiff, brown, slightly gravelly, slightly sandy CLAY with a low to medium cobble content and occasional thin to thick bands of brown, fine to coarse sand to a depth of c. 57m bgl, underlain by:
- **Manchester Marls Formation and Collyhurst Sandstone Formation**

#### 4.2.1 Geotechnical Hazard Identification

Potential geotechnical hazards based on the expected ground conditions that may require further consideration at the site are outlined below:

| Factors                                  | Remarks                                                                                                                                                                     | Considerations                                                                                                                                                                                                                                                                                                                                                                                            | Risk                   |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| <b>Made Ground</b>                       | Widespread Made Ground may be present on-site which may be deep in areas i.e. if the historical dwellings had basements or in the vicinity of the underground storage tank. | Made Ground may settle variably, have highly inconsistent bearing capacity and may suffer significant movements that may be problematic for foundations, externals and infrastructure elements without treatment. The presence of Made Ground may be problematic for foundations as there may be loose / soft spots within the Made Ground and it may not be suitable to utilise traditional foundations. | <b>Low to Moderate</b> |
| <b>Aggressive Ground and Groundwater</b> | While the risk posed from the natural strata is anticipated to be very low, given the anticipated presence of localised Made Ground there is the potential for              | Acidic ground / groundwater and sulfate may attack the concrete and steel used in foundations and react with aggregates. The oxidation of pyrite and other sulfides can also occur due to geotechnical activities. This can lead to the generation of high                                                                                                                                                | <b>Low to Moderate</b> |

|                               |                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                        |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
|                               | aggressive ground conditions to be present on-site, however, the risk remains low.                                                                                                                                                                                                        | concentrations of sulfate and low pH that attacks construction materials and may lead to the precipitation of gypsum resulting in the heave of foundations and floor slabs. Pyrite oxidation can also be triggered by mixing susceptible materials with lime or cement resulting in high pH that can lead to the expansion of some sulfates that cause heave of stabilised soils.                                                                                |                        |
| <b>Shrink and Swell Clays</b> | Established trees are present along the boundaries of the site and in the south western site section. Low to moderate volume change potential Glacial Till is anticipated at shallow depth, therefore localised deepening of foundations or the use of heave precautions may be required. | Some types of ground (e.g., clay soils) can change volume due to fluctuations in moisture content that may be induced by weather variations (e.g., drought), vegetation (e.g., growth or removal of trees) or man-made activities (e.g., changes to local drainage). This shrink / swell behaviour typically causes ground movement to a depth of approx. 3m, potentially damaging building foundations, externals, pipes or services by differential movements. | <b>Low to Moderate</b> |
| <b>Obstructions</b>           | An underground storage tank is anticipated to be present in the north eastern site section. Additional obstructions associated with the current and historical site buildings may also be present on-site.                                                                                | May act as obstructions to excavations and / or the chosen foundation solution or act as 'hard spots' within the ground if left in-situ.                                                                                                                                                                                                                                                                                                                         | <b>Low to Moderate</b> |
| <b>Retaining Wall</b>         | A c. 0.50m - 1.00m retaining wall is present along the eastern extent of the northern boundary of the site. The retaining wall was noted to be in good condition.                                                                                                                         | The retaining wall will need to be inspected and remedial measures undertaken prior to development, subject to an assessment of the impact upon Third Party assets.                                                                                                                                                                                                                                                                                              | <b>Low</b>             |

### 4.3 Sources of Contamination and Probable Contaminants

Based on the desk study information the following potentially contaminative on-site sources have been identified:

| Potentially Contaminative Source                                                  | Associated Determinands                                                                                                                                                    | Remarks                                                                                                                                                                                                                                                                                   | Hazard          |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>On-Site Made Ground</b>                                                        | Unknown, anticipated to be metals, semi-metals, PAHs, TPH, asbestos.<br><br>Ground Gas – carbon dioxide, methane, hydrogen sulfide, VOCs                                   | Widespread Made Ground anticipated of unknown composition and depth may be deep in areas i.e. if basements were present associated with the historical terraced dwellings.<br><br>Contaminative hotspots possible within the Made Ground associated with historical and current site uses | <b>Moderate</b> |
| <b>On-Site Existing Fire Station (including tank, boiler room, chemicals etc)</b> | Wide range of determinands including metals, semi-metals, PAHs, TPH, asbestos, and possible firefighting foams including PFOS, PFOA, fluorinated hydrocarbons, surfactants | An underground storage tank for diesel is suspected in the north eastern site section as well as a hydrocarbon spirit storage, Adblue drums and a boiler room is also present on-site therefore contaminative hotspots may be present, particularly hydrocarbon hotspots.                 | <b>Moderate</b> |
| <b>Historical Allotment Gardens</b>                                               | Herbicides and Pesticides                                                                                                                                                  | Allotment gardens were historically recorded in the eastern site section therefore herbicides and pesticides may have been used on a small scale.                                                                                                                                         | <b>Low</b>      |

|                                                                |                                                                      |                                                                                                                                                                                            |                        |
|----------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| <b>Historical and Existing Off-Site Industrial Uses</b>        | Unknown, anticipated to be metals, semi-metals, PAHs, TPH, asbestos. | Numerous cotton mills, upholstery and confectionary works and a smithy have been present within 250m of the site since the late 19 <sup>th</sup> century.                                  | <b>Low to Moderate</b> |
| <b>Off-Site Infilled Reservoirs (30m - 70m, 1940s - 1970s)</b> | Ground Gas – carbon dioxide, methane, hydrogen sulfide, VOCs         | Historical reservoirs were present c. 30m and 70m south and south east of the site respectively, associated with off-site mills. The reservoirs were infilled between the 1940s and 1960s. | <b>Low to Moderate</b> |

It should be noted that potentially contaminative unrecorded historic activities may have occurred (e.g. the use or deposition of Made Ground from off-site during historic on-site developments) and in this event, further contaminative sources may be present.

#### Fire Fighting Foam (PFAS)

Anecdotal evidence from operations chief on site (over previous 15 years) stated that firefighting foam had not been used at the site, despite the presence of a training tower. It has been communicated to IGE that training with foam only took place at designated stations where fighting foam was stored in tanks and that Whitefield Fire Station was not one of these.

#### 4.3.1 Unknowns

Following the desk study, the areas of uncertainty are summarised as follows:

- Depth of Made Ground
- Depth and extent of Glaciofluvial Deposits
- Size of suspected underground tank and whether it has been decommissioned
- Depth to groundwater
- Use of fire fighting foam (PFAS) in 20<sup>th</sup> Century on site

### 4.4 Pathways for Contamination

#### 4.4.1 Human Health

The pathways along which contamination could potentially reach the receptors on-site during use and after completion of development works are detailed in 'Updated Technical Background to the CLEA Model' (Environment Agency 2009) but can be summarised as follows:

#### End Users (Commercial Land Use Scenario):

- Ingestion of soil directly and indoor dust\* including on home-grown produce;
- Inhalation of soil dust (indoor and outdoor);
- Dermal contact with soil (indoor and outdoor);
- Inhalation of soil vapours (indoor and outdoor);
- Oral background;
- Inhalation background.

*\* Treated as one pathway*

#### 4.4.2 Controlled Waters

The pathways along which contamination could potentially reach the controlled waters receptors during use and after completion of development works are as follows:

- Vertical migration along current and / or future foundations and pooling at base / beneath foundations.
- Vertical migration through possible granular Made Ground and granular lenses in natural cohesive deposits.
- Lateral migration along low permeability natural deposits and pooling at relative low points.
- Negligible infiltration through low-permeability natural cohesive deposits.
- Migration through porous sandstone bedrock.
- Migration along groundwater flow.
- Overland flow

#### 4.4.3 Ground Gas Pathways

The pathways along which ground gas could potentially reach the receptors on-site during use and after completion of the development works are as follows:

- Migration through fractures and fissures in bedrock
- Preferential migration along foundations, service ducts / trenches
- Migration within groundwater
- Ingress through wall cavities and floors and accumulation
- Inhalation of ground gas and vapours

## 4.5 Receptors of Contamination

Human Health receptors for these pathways include the following:

- End Users (commercial land use scenario)
- Construction workers.
- The general public and adjacent site users.

Controlled waters receptors for these pathways include the following:

- Groundwater contained within the underlying Secondary Undifferentiated Aquifer, Secondary A Aquifer and Principal Aquifer.
- Surface Water – None identified within 500m of the site. The River Irwell, located 710m from the site, is not considered a surface water receptor due to the distance between the site and river,

Other receptors for these pathways include the following:

- Subsurface plastic (e.g. potable plastic water pipe).
- Building fabric (e.g. concrete foundations, etc.)

## 4.6 Conceptual Model

### 4.6.1 Conceptual Model for Human Health Assessment

A site conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for the human health of site occupants has been produced as a result of the probable contaminants, pathways and receptors identified above.

| Sources of Contamination | Pathway                                                                                              | Receptor                     | Hazard (severity)                         | Likelihood                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Risk                   |
|--------------------------|------------------------------------------------------------------------------------------------------|------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| On-Site Made Ground      | Ingestion of contaminated soil and dust (indoor and outdoor)<br><br>Dermal contact with contaminated | End users and general public | Effect on human health<br><b>(Medium)</b> | <b>Likely:</b> Made Ground is anticipated across the site and may be deep in areas (i.e. around the existing tank and if basements were historically present on-site). Although widespread contamination is not anticipated, localised contaminative hotspots may be present in the vicinity of the existing diesel underground storage tank, boiler room, interceptor, petroleum spirit storage and within the Made Ground. Historical hotspots of ashy material may | <b>Low to Moderate</b> |

|                                                                            |                                                   |                                                      |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |
|----------------------------------------------------------------------------|---------------------------------------------------|------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| On-Site Existing Fire Station (including tank, boiler room, chemicals etc) | soil (outdoor and indoor)                         | Inhalation of contaminated dust (indoor and outdoor) |                              | also be present associated with the historical residential dwellings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |
|                                                                            |                                                   |                                                      |                              | <p>Whilst anecdotal evidence suggests that the storage and use of firefighting foams potentially containing PFAS at the station was unlikely, it cannot be completely discounted.</p> <p>Although allotment gardens were historically present on-site until the 1960s therefore there is potential for herbicides and pesticides to have been used, they are not likely to include the persistent organochloride pesticides such as Dieldrin, Aldrin, DDT etc. Pesticides and herbicides routinely used in the UK degrade in soils or leach via rainwater infiltration to groundwater.</p> <p>Ingestion, dermal and inhalation pathways will be reduced across the majority of the site given the presence of hardstanding i.e. roads and buildings. However, the soft landscaping area in the southern site section will be at increased risk.</p> |                 |
| Historical 20 <sup>th</sup> Century use of fire fighting Foam (Unknown)    |                                                   |                                                      | Construction workers         | <p><b>Likely:</b> Construction workers will be at increased risk due to their acute interaction with soils, however, given the lack of identified potentially contaminative sources the risk remains low. The appropriate use of PPE, Good Practice and Health and Safety Measures will also significantly reduce the risk.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Low to Moderate |
|                                                                            |                                                   |                                                      | End users and general public | <p><b>Low Likelihood:</b> No widespread potential sources of VOCs (including PFAS) have been identified. If localised contaminative hotspots of VOCs are present (i.e. from possible spillage from hydrocarbon spirit storage or diesel tank), given their relative mobility and volatility, VOCs are unlikely to remain at significant concentrations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |
| Historical and Existing Off-Site Industrial Uses                           | Inhalation of soil vapours (indoors and outdoors) |                                                      | Construction workers         | <p><b>Low Likelihood:</b> Construction workers at increased risk if any disturbance of soil occurs as this may generate a temporary increase in the release of soil vapours, however risk remains low given the lack of a source of VOCs including PFAS.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Low to Moderate |
|                                                                            |                                                   |                                                      |                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |

A diagram of the conceptual site model is contained within Appendix 2.

#### 4.6.2 Conceptual Model for Ground Gas Risk Assessment

A conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for ground gas has been produced as a result of the probable contaminants, pathways and targets identified above as follows:

| Source                                                  | Pollutant                          | Pathway                                                                                   | Receptor                        | Hazard (severity)               | Likelihood of Occurrence                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Risk                   |
|---------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Made Ground                                             | Methane                            | Preferential migration along foundations, service ducts / trenches                        | Human occupants<br>Site Workers | Human occupants<br>Site Workers | <b>Low Likelihood:</b> Made Ground is anticipated to be present across the site and may be deep in areas (>1m bgl). However, the Made Ground is unlikely to contain significant organic rich or putrescible material. Consequently, the Made Ground is anticipated to be a low ground gas generation source.                                                                                                                                                                                                                                                                                                                                                 | <b>Low</b>             |
|                                                         |                                    |                                                                                           | Building and Structures         | Building and Structures         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |
| Off-Site Infilled Reservoirs (30m - 70m, 1940s - 1970s) | Carbon Dioxide<br>Hydrogen Sulfide | Ingress through wall cavities and floors and accumulation<br><br>Inhalation of ground gas | Human occupants<br>Site Workers | Human occupants<br>Site Workers | <b>Low Likelihood:</b> Although 2 No. infilled reservoirs exist in close proximity to the site (30m - 70m south and south east), they were infilled between the 1940s and 1960s / 19670s. Therefore, these are considered to be a low to moderate ground gas generation source in-line with BS8576 (2013) Figure 6: Decision Matrix Tool. However, lateral migration of ground gas onto site from the infilled reservoirs is deemed unlikely given the anticipated presence of granular superficial deposits (Glaciofluvial Deposits) between the sources and site which will facilitate vertical migration to the atmosphere rather than lateral migration. | <b>Low to Moderate</b> |
|                                                         |                                    |                                                                                           | Building and Structures         | Building and Structures         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |

\*Due to the risk of explosion.

A diagram of the conceptual site model is included within Appendix 2.

#### 4.6.3 Conceptual Model for Waters Risk Assessment

A site conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for pollution of waters has been produced as a result of the probable contaminants, pathways and targets identified above as follows:

| Source                                                                     | Pathway                                                                   | Receptor                                                                              | Hazard (severity)                   | Likelihood of Occurrence                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Risk |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| On-Site Made Ground                                                        |                                                                           |                                                                                       |                                     | <b>Pre-Development Site</b><br><b>Low Likelihood:</b> Although potential contaminative sources have been identified on-site as well as possible contamination hotspots, vertical migration of contaminants to the underlying aquifers is deemed unlikely.                                                                                                                                                                                                                                                                                                             | Low  |
| On-Site Existing Fire Station (including tank, boiler room, chemicals etc) | Vertical migration along current and future foundations                   | Groundwater within the Secondary Undifferentiated, Secondary A and Principal Aquifers | Effects to controlled waters (Mild) | This is because the majority of the site is currently covered by hardstanding which will reduce infiltration; drainage is also present which will reduce infiltration into the underlying ground. Additionally, a significant thickness of cohesive Glacial Till is anticipated (to c. 57m bgl) which will negate any migration to the underlying Principal Aquifer. The Secondary Undifferentiated and Secondary A Aquifers within the superficial deposits are not anticipated to be shallow therefore vertical migration to the saturated zone is deemed unlikely. |      |
| Historical use of fire fighting foam (Unknown)                             | Vertical migration through granular Made Ground and / or natural deposits |                                                                                       |                                     | Whilst the use of fire-fighting foam is considered unlikely at the site, any historical use could lead to the presence of PFAS across the site. If present, higher concentrations may be recorded within drainage runs, joints in concrete slabs and manhole sumps. Given that anecdotal evidence suggests no known use for at least 15 years, any concentrations noted are likely to be residual.                                                                                                                                                                    |      |
| Historical Allotment Gardens                                               | Negligible infiltration through low permeability cohesive deposits        |                                                                                       |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |
|                                                                            | Migration through porous bedrock                                          |                                                                                       |                                     | <b>Post Development Site</b><br><b>Low Likelihood:</b> Following development, the majority of the site will still be covered in hardstanding therefore there will be not increase in infiltration. Furthermore, if any significant contamination is encountered, then remedial measures may be undertaken (i.e. possible removal of source) further reducing the risk to controlled waters. If the suspected underground diesel tank is not in use, this may be removed during development, as well as the existing boiler room, leading to a betterment.             | Low  |
| Historical and Existing Off-Site Industrial Uses                           |                                                                           |                                                                                       |                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |

|  |                                                                                                                                                                          |                       |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|  | Lateral migration along low permeability cohesive deposits<br><br>Lateral migration along historic drainage<br><br>Migration along groundwater flow<br><br>Overland Flow | Surface water courses | Low | <b>Pre and Post-Development Site:</b><br><b>Unlikely:</b> Lateral migration of contaminants is considered unlikely given the lack of nearby surface water features. The nearest is located >700m from the site (River Irwell) therefore lateral migration will be negated due to the distance and anticipated lack of shallow groundwater. Overland flow is also not a feasible pathway given the presence of significant drainage systems on and off-site. | Low |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|

A diagram of the conceptual site model is included within Appendix 2.

#### 4.7 Preliminary Risk Assessment Summary

##### Human Health

Based on the human health conceptual model the risk to human health is deemed low to moderate to end users and construction workers as contaminative sources have been identified on-site and some contaminative linkages may be present in areas of soft landscaping. Although the risk to construction workers is increased due to their acute interaction with site soils, it is envisaged that with appropriate PPE and site management, risks to construction workers can be mitigated. The risk, therefore, remains low.

##### Ground Gas

Ground gas sources have been identified on-site and in close proximity to the site, therefore the ground gas risk is deemed low to moderate. Consequently, it is recommended that ground gas monitoring is undertaken including 6 No. visits over 3 months to determine the ground gas regime.

If any organic rich Made Ground deposits are identified or if previously unrecorded potential ground gas sources are recorded during the ground investigation works, further ground gas monitoring may be required. The length and frequency of the ground gas monitoring regime and the sampling method, initial results and alterations to the conceptual model are subject to the findings of the ground investigation works

and development constraints (i.e. development timescales and liaison with the local authority).

#### Controlled Waters

Although sensitive receptors have been identified on-site (Principal, Secondary Undifferentiated and Secondary A Aquifers) no significant contaminative linkages exist, therefore the risk to controlled waters is deemed low.

If unrecorded contaminative sources are noted, the above conceptual models may require re-assessment / re-appraisal.

### **4.8 Scope of Phase 2 Intrusive Geo-Environmental Ground Investigation**

As a result of the preliminary risk assessment a Phase 2 intrusive geo-environmental ground investigation should be carried out to quantify the identified risks. This intrusive ground investigation works should include the collection of appropriate samples – solid, leachate and / or liquid, if deemed necessary, across the site for appropriate chemical testing as detailed above.

Furthermore, to determine the geotechnical and geological properties of the underlying ground conditions, appropriate intrusive works and associated testing should be undertaken. The rationale and aims for these Phase 2 environmental, geotechnical and geological investigative works are detailed below.

In order to provide adequate assessment in terms of both environmental and geotechnical site parameters, ground investigation works will be required on a spatial basis and targeting the following features:

- Area of underground tank / interceptor / chemical storage
- Boiler Room

The proposed initial ground investigation works are subject to confirmation with the designer for the scheme, but it is recommended that the works should comprise at least the following:

- Dynamic Sampling Boreholes or Trial Pits
- Cable Percussive Boreholes
- Installation of gas and groundwater monitoring wells

The rationale for the exploratory holes is discussed below:

- To allow the collection of samples from the Made Ground and natural deposits for chemical laboratory testing (solid samples) for an appropriate suite of determinands and for soluble sulfate (2:1 extract) and / or total sulfate and pH testing to determine the suitable concrete classification in associated with relevant guidance e.g. BRE Special Digest 1.
- To determine the extent, composition and depth of any Made Ground deposits.
- To determine the nature, thickness and extent of superficial deposits.
- Enable in-situ and ex-situ geotechnical testing, including density testing (SPTs), hand shear vane (HSV) testing and undrained shear strengths of the underlying Made Ground and natural deposits for the purposes of sub-structure design;
- To allow installation of ground gas monitoring wells.

Based on the findings of the initial ground investigation works, further works may be required for detail design including CBR determinations and infiltration (soakaway) testing.

#### 4.8.1 Scope of Further Works - PFAS

Anecdotal evidence suggests that the likelihood of firefighting foam having been historically used at the site is low. However, this cannot be confirmed.

The controlled waters conceptual model for the site indicates a significant thickness of Glacial Till beneath the site. This is classified as a Secondary (undifferentiated) Aquifer and is anticipated to be broadly cohesive in nature and to act as a barrier to any lateral and vertical migration of contaminants. Any bands of granular strata which may be present within the Glacial Till are anticipated to not be laterally continuous nor in hydraulic connectivity with the above Made Ground or Glaciofluvial Sheet Deposits (Secondary A Aquifer).

Upon consideration of the low likelihood of the historical use of fire fighting foam and the conceptual site model for controlled waters, it is assessed that the risk of potential PFAS compounds reaching sensitive receptors, especially the Principal Aquifer within the bedrock, is low.

In order to confirm the classification of the site as a **low level risk**, it is recommended that a baseline survey be conducted involving the collection and testing of samples for the presence of PFAS compounds. These samples should be taken from the material directly below the concrete slab i.e. sub-base materials, with exploratory hole locations chosen in areas beneath clearly visible joints or cracks within the concrete i.e. high risk pathways through the concrete slab.

Sampling will also include for a 'site blank' i.e. sample of site superstructure to give a background concentration and a laboratory blank. It is not proposed to test either the overlying concrete or any deeper material (either Made Ground or natural deposits) unless significant concentrations are recorded within the initial round of testing on the sub-base. The testing should be in-line with specification from a laboratory with MCERTS accreditation in line with Environment Agency standards.

It is assessed that if PFAS compounds are present within the sub-base material, they will be present within the overlying concrete slab. It is currently proposed to process and re-use the concrete on site as a site-won aggregate. The presence of PFAS compounds does not preclude this, though it may restrict the use of this material to within unsaturated zones.

Further testing on concrete, deeper Made Ground and natural deposits may also be necessary if significant concentrations of PFAS are recorded on the sub-base material. Following discussion with MCERTS accredited laboratory sampling methods / techniques supplied will be adhered to mitigate risk of acute cross contamination.

It is recommended that the above strategy is confirmed to be acceptable by the Environment Agency before it is undertaken.

## 5.0 RECOMMENDATIONS

- 5.1 As a result of the information gathered and the risks identified in this report, there is a low to moderate risk to human health on the basis that feasible contaminative linkages have been identified for end users and construction workers in localised areas. The risk to controlled waters is deemed low given the lack of significant contaminative linkages.
- 5.2 A low to moderate ground gas risk has been identified based on ground gas sources therefore ground gas monitoring including 6 No. visits over 3 months is recommended. On the basis that the site lies within an area where between less than 1% of homes are above the action level no radon protection measures are necessary.
- 5.3 Due to geotechnical requirements, ground investigation works should be undertaken in order to determine the ground conditions with a greater degree of certainty and allow design of the proposed development, drainage, services and immediate external areas to be undertaken. It is therefore recommended that exploratory holes are constructed where access is permitted across the site. The use of soakaways is unlikely to be suitable given the presence of low-permeability shallow Glacial Till across the site.
- 5.4 From the results of the Phase 2 ground investigation work – if this report identifies a potential risk and / or a requirement for further detailed site-specific assessment, a Phase 3 environmental investigation report and / or a Remedial Strategy (informing on potential remediation solutions) may be required.
- 5.5 The nature and extent of the proposed targeted chemical and environmental testing should be confirmed, if time / commercial constraints allow, with the relevant Local Authority Environmental Health Officer and the Environment Agency prior to undertaking works on-site. Proceeding without agreement between regulatory authorities may result in further assessment being required.

- 
- 5.6 It should be noted that, if any visual or olfactory evidence of contamination is encountered during remediation or construction work, then the Local Authority Environmental Health Officer and Environment Agency should be contacted immediately in order to agree any necessary remediation measures.
- 5.7 Given the possibility of services on-site, full service plans and a GPR scan should be obtained prior to any intrusive ground investigation works.
- 5.8 Due to the presence of established trees on-site and the presence of cohesive deposits, an arboricultural survey is recommended.
- 5.9 The further works to identify the risk from PFAS at the site as detailed in §4.8.1 should be completed, including liaison with the Environment Agency.