



**Fusion Manchester Devco Ltd**

# **Deansgate, Manchester**

Foundation Works Risk Assessment

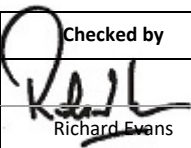




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# Deansgate, Manchester

## Foundation Works Risk Assessment

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Shear Design Drawing DSM-SDL-ZZ-FX-DR-ST-0001-P02 – General arrangement: Pile Layout

## 1 INTRODUCTION

### 1.1 Terms of Reference

- 1.1.1 TEC has been appointed by Rhomco on behalf of Fusion Manchester Devco Ltd to prepare a Foundation Works Risk Assessment (FWRA) for the proposed piled foundations at Deansgate, Manchester. All works were undertaken in accordance with our proposal email dated 11 July 2023.

### 1.2 Background

- 1.2.1 The site is a roughly triangular shaped plot of disused land located off the junction between Deansgate and the A56 Bridgewater Viaduct in the southwest of Manchester City centre (Figure 1). It is approximately 0.06ha in size, with the centre of the site located at approximate National Grid Reference SJ 83294 97433. The nearest postcode is M15 4TP.

- 1.2.2 The proposed development is understood to comprise the construction of 534 No Purpose Built Student Accommodation units within a 28-storey building (Figure 2). The triangular building would take up virtually the whole site with a lower ground floor level, accessed from Deansgate South, would be ancillary accommodation including cycle and refuse stores, while the main entrance at ground floor level would be at the south-west tip of the building and would accommodate reception and office space, lounge, social and game spaces, a laundry and ancillary accommodation around a stair and lift core. At first floor level there would be a gym, a wellbeing suite and communal study space. At all other floor levels there would be study bedrooms in a variety of arrangements. Rooftop terraces are proposed at three levels: 22, 24 and 26 and would be available to students as external recreational spaces.

- 1.2.3 It is understood that a planning application (Ref: 129406/FO/2021) has been submitted to Manchester City Council, with an appeal decision (ref: APP/B4215/W/21/3287525) granting full planning permission for the proposed development. The Schedule of Conditions for Planning Permission 129406/FO/2021, contained within the Appeal Decision includes Condition 5, which states:

*“Prior to the commencement of development (other than demolition and site clearance), details of piling using penetrative methods shall not be carried out other than with the written approval of the local planning authority. Development shall be carried out in accordance with the approved details.”*

- 1.2.4 This document has been produced to address the above condition.

#### Previous Reporting

- 1.2.5 The following TEC report has been prepared for the proposed development, as detailed within the following report:

- Deansgate, Manchester – Ground Investigation Report. Prepared for Manchester Devco Ltd, referenced 2006023.001.01 and dated October 2022

- 1.2.6 In addition, a number of previous assessments have been undertaken for the site, which were provided to TEC by the Client, and reviewed as part of the Ground Investigation Report detailed above. The reports provided for review are detailed below:

- Deansgate South, Manchester: Phase I (Desk Study) Investigation Report by Opus. Report ref: J-W0501.02 prepared for Knott Mill Securities Ltd.
- Deansgate South, Manchester: Phase I Preliminary Risk Assessment Report by WSP. Report ref: 11742(1) prepared for Fusion Manchester Devco Ltd.
- Deansgate South, Manchester: Factual Report on Ground Investigation by Structural Soils Ltd. Report ref: 764121 prepared for Buro Happold Engineering.

- 1.2.7 It is assumed these previous reports can be relied upon, although TEC hold no responsibility for the validity of third-party information.

- 1.2.8 While the salient information from these reports has been summarised within the following sections, reference should be made to the above reports for full details.

### 1.3 Scope of Works

1.3.1 The aim of these works is to provide information on the foundation designs and constraints associated with the site with regard to the proposed development.

1.3.2 The scope of work undertaken as part of this FWRA report is presented below:

- Review of the existing geoenvironmental and geotechnical data pertaining to the site and its surroundings;
- Development of the understanding on potential contaminant migration pathways;
- Development of a suitable rationale behind the foundation selection;
- Risk assessment to justify the foundation selection;
- Description of the mitigation measures necessary for the identified risks; and
- Provision of monitoring considered necessary during and post the construction works.

### 1.4 Methodology

1.4.1 The methodology is outlined by the recommendations made by the Environment Agency's Report titled *"Piling into Contaminated Sites"*, February 2002 and the National Groundwater and Contaminated Land Centre Report NC/99/73: *"Piling and penetrative ground improvement methods on land affected by contamination: Guidance on pollution prevention"* within which six possible contamination pathways are identified by the Environment Agency. These six contamination scenarios are refined to incorporate the site-specific conceptual model and, the piling methodology will be chosen that mitigates the possible contamination pathways and fits with the scope of the development.

1.4.2 The FWRA therefore considers the:

- Creation of preferential pathways (breaching of impermeable layers), allowing contamination to migrate and impact the underlying aquifer or allowing gas to migrate upwards posing a risk to the proposed structures;
- Breaching of impermeable layers, allowing contamination to migrate and impact the underlying aquifer or allowing gas to migrate upwards posing a risk to the proposed structures;
- Risks associated with the piling method, i.e. potentially driving made ground and potentially contaminated materials downwards into the underlying natural strata during pile construction;
- Generation of contaminated soil arisings posing a risk to human health;
- Disposal requirements of soil arisings;
- Effects of aggressive ground conditions on buried concrete;
- Effects of the piling method on the surrounding environment; and
- Potential for contamination of surface and groundwater from pile construction materials.

### 1.5 Limitations

1.5.1 The findings and opinions conveyed via this assessment are based on information obtained from a number of sources as detailed within this report, TEC have assumed this information is correct and may be relied upon.

1.5.2 Any recommendations made in this report should be confirmed with the Regulatory Authorities prior to implementation to ensure compliance.

1.5.3 This assessment has been based on the proposed planning layouts provided. Any subsequent change to the planning layout may have an impact on the validity of recommendations made within this report. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

## **2 DATA REVIEW**

### **2.1 Site Location and Description**

- 2.1.1 The site is located off the junction between Deansgate and the A56 Bridgewater Viaduct in the southwest of Manchester City centre. The site is approximately 0.06ha in size, with the centre of the site located at approximate National Grid Reference SJ 83294 97433. The nearest postcode is M15 4TP.
- 2.1.2 During the site reconnaissance survey undertaken in August 2022, the site was observed to comprise a triangular shaped plot of disused land covered entirely with concrete hardstanding, although areas of scrub vegetation were noted as present in areas where the slab had been damaged.
- 2.1.3 The site was bordered by wooden hoarding on all sides except for along the north-eastern perimeter where a brick built retaining structure was present. In the northern corner of site, a section of brick wall that appeared to be the remnants of a historical structure, as evidenced by blocked windows and vents, bridged over a small section of the adjacent access road just off site and ran southeast into the site by approximately five metres.
- 2.1.4 Access to the site was obtained through a gate in the western corner of the hoarding off Deansgate Road near the junction with the A56.

### **2.2 Proposed Development**

- 2.2.1 The proposed development is understood to comprise the construction of 534No. Purpose Built Student Accommodation units within a 28-storey building taking up virtually the whole site and including a lower ground floor level, accessed from Deansgate South, providing ancillary accommodation, a ground floor accommodating reception and office space, lounge, social and game spaces, a laundry, and a first floor level gym, wellbeing suite and communal study space.

### **2.3 Site History**

- 2.3.1 Earliest available mapping reportedly recorded the site as forming park of the wider 'The Old Warehouse' wharf development to the north. The western part of the site was occupied by several buildings, with an additional smaller building to the north and notably a 'pump' in the eastern corner. This layout was changed by 1893, with the site appearing distinctly separate from adjacent works areas and featured two buildings parallel with the north-eastern boundary. The WSP 2021 report suggested that the retaining structure along the north-eastern perimeter was likely constructed prior to 1893.
- 2.3.2 Minor alterations to the site layout reportedly occurred in 1948 and 1951 when buildings were removed and replaced by a garage in 1960, interpreted by WSP to include a canopy/forecourt to the west and a building to the east which was likely a shop. No notable changes to the site layout were reported until mapping dating to 2010 which suggested the site was vacant. Imagery from Google Earth Pro shows that the contemporary concrete slab was likely associated with construction activities on a nearby site.

### **2.4 Environmental Setting**

- 2.4.1 The geology for the site is reported to comprise sands and gravels of the superficial Glaciofluvial Deposits, underlain by sandstone bedrock of the Chester Formation.
- 2.4.2 The Glaciofluvial Deposits are designated by the Environment Agency as a Secondary A Aquifer, whilst the Chester Formation is designated as a Principal Aquifer. Whilst the site is not located within a Source Protection Zone, there are eight groundwater abstractions recorded within 1km of the site, the nearest of which is reported approximately 575m to the north.
- 2.4.3 The nearest surface water feature was identified as the River Medlock located approximately 50m east of the site, which supplies the Castlefield Canal Basin 50m to the north. It is reported that the eastern half of the site lies within an Environment Agency Zone 2 flood zone.
- 2.4.4 There are no historical landfill sites recorded within 250m of the site, nor any records of historical mining or historical cavities within 1km. A number of potentially significant current and historic land uses have been reported within 500m of the site, including numerous industrial or engineering sites, two petrol/fuel

sites (both of which listed as obsolete), sixty-five historical garages or vehicle repair sites and ten historical tanks.

## 2.5 Encountered Ground Conditions

2.5.1 Intrusive works undertaken by TEC in August 2022 recorded the following generalised ground profile for the site.

**Table 2.1: Generalised Ground Profile**

| Depth (mbgl)                             | Encountered Material                                                                                                                        |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>MADE GROUND</b>                       |                                                                                                                                             |
| 0.0 – 0.23/0.5                           | Light grey reinforced concrete with 3-5mm rebar.                                                                                            |
| 0.23 – 1.0/3.5                           | Reddish brown slightly clayey slightly gravelly sand with low cobble content. Gravels and cobbles of concrete, chert, sandstone and quartz. |
| 0.5 – 4.0 (BH101)                        | Brown slightly gravelly sand with gravel of brick, concrete and asphalt and weak petrol odour.                                              |
| 0.23 – 1.0 (BH102)                       | Dark brown to greyish brown slightly clayey gravel of tarmac, concrete and limestone                                                        |
| <b>SOLID GEOLOGY – CHESTER FORMATION</b> |                                                                                                                                             |
| 1.5/3.5 – 2.0/4.45 (BH102 & BH103)       | Firm reddish brown to dark brown slightly gravelly slightly sandy clay with gravel of fine to medium sub-angular to rounded chert           |
| 1.5/4.0 – 1.0/7.0                        | Medium dense reddish brown slightly clayey fine to medium sand.                                                                             |
| 1.0/7.0 – >25.0                          | Extremely weak to weak becoming moderately strong to strong reddish brown fine to medium sandstone                                          |

2.5.2 While superficial Glaciofluvial Deposits have been depicted on geological mapping for the site, no superficial deposits were encountered during the intrusive works.

## 2.6 Groundwater

2.6.1 Groundwater strikes were unable to be discerned during drilling due to water added to aid drilling. Standing depths of the groundwater within the boreholes recorded as part of subsequent monitoring visits at the site are summarised in Table 2.2 below.

**Table 2.2: Summary of Groundwater Conditions**

| Location            | Standing Depths (mbgl) |            |            | Strata            |
|---------------------|------------------------|------------|------------|-------------------|
|                     | 17.08.2022             | 31.08.2022 | 29.09.2022 |                   |
| BH101               | 2.7                    | 7.12       | 7.07       | Chester Formation |
| BH102               | 2.5                    | 7.28       | 7.08       |                   |
| BH103               | 3.31                   | -          | -          |                   |
| BH104               | 2.94                   | -          | -          |                   |
| BH03 <sup>(1)</sup> | -                      | -          | -          |                   |

Note: 1. Borehole installed by Structural Soils in 2016

2.6.2 An initial monitoring visit, conducted immediately post drilling, showed groundwater levels resting at approximately 2.5 to 3.3mbgl. However, during subsequent monitoring visits standing groundwater levels were noted to be at approximately 7.0mbgl.

2.6.3 It should be noted that groundwater conditions recorded during the investigation may not be representative of long-term conditions and that groundwater levels may vary in response to meteorological/ seasonal changes.

## 2.7 Contamination Summary

### Human Health

- 2.7.1 Only localised Contaminants of Potential Concern (CoPC), in relation to a chronic risk to human health (site end users), have been identified within the made ground encountered on site, with elevated PAH (dibenz(a,h)anthracene) reported within a single location (TP102 at 0.4mbgl – 0.8mbgl) when considering a public open space (residential) site end use. All remaining determinands tested were reported to be below the relevant GAC.
- 2.7.2 While olfactory evidence of potential hydrocarbon contamination was recorded within the natural ground materials encountered within BH03 between 3.7mbgl and 4.0mbgl, laboratory analysis of this material recorded TPH to be below the relevant GAC and therefore, no CoPC were identified within the natural ground.

### Visual or Olfactory Evidence of Contamination

- 2.7.3 Hydrocarbon odours and black staining were recorded within the made ground and the upper part of the Chester Formation in BH102. However, screening of the soil samples with a photo-ionisation detector (PID) recorded no concentrations of VOC above the instrument's minimum detection limit.
- 2.7.4 Screening of made ground materials from BH101 (noted to have a weak petrol odour, which was positioned in proximity to the locations of former petrol station tanks), with a PID recorded VOC concentrations of 5.5ppmv at 0.6mbgl, which increased to a maximum of 305ppmv at 1.5mbgl, before decreasing to 81.5ppmv at 3.5mbgl. Screening of the natural Chester Formation underlying these made ground materials recorded VOC concentrations that continued to decrease to 0.7ppmv at 6.3mbgl.
- 2.7.5 In addition, a rock sample recovered from a depth of 6.4m at BH102, recorded a "hydrocarbon smell".

### Controlled Waters

- 2.7.6 Leachate analysis of representative made ground materials was undertaken as part of the Waste Acceptance Criteria testing for the site.
- 2.7.7 The results of the assessment recorded a number of exceedances of the GAC and therefore, the following leachable contaminants of potential concern (CoPC) were identified at the site:
- Heavy metals (chromium, mercury, zinc and barium);
  - Total phenol (monohydric)
- 2.7.8 In addition, groundwater samples were collected from the two deeper installed borehole monitoring wells (BH101 and BH102), the response zones for which are within the natural ground (Chester Formation).
- 2.7.9 The results of the assessment recorded exceedances of the GAC and therefore, the following contaminants of potential concern (CoPC) were identified within the groundwater at the site:
- PAH (naphthalene);
  - Total phenol (monohydric);
  - TPH-CWG Aromatic (EC5 – EC7); and
  - Benzene.
- 2.7.10 In addition, a number of VOC and SVOC concentrations were detected above the minimum detection limit within the groundwater, including VOC's: BTEX, Isopropylbenzene, n-Propylbenzene and 1,3,5-Trimethylbenzene and SVOC's: Aniline, 2,4-Dimethylphenol and 2-Metylnaphthalene.
- 2.7.11 It is noted the leachable heavy metals identified within the made ground were not detected at significant concentrations within the sampled groundwater considered to pose a risk to the identified controlled water receptors.

Concrete

- 2.7.12 In accordance with BRE Special Digest 1, the results of water-soluble sulphate and pH testing undertaken on representative samples of the made ground and groundwater sampled yielded an Aggressive Chemical Environment Class (ACEC) of AC-1, requiring Design Sulphate Class DS-1.

Potential Sources of Ground Gas

- 2.7.13 Made ground was encountered across the site to a maximum depth of 4.0mbgl. In addition, hydrocarbon impacted materials, associated with the former PFS, were recorded on site.
- 2.7.14 3No. rounds of ground gas monitoring undertaken at the site recorded maximum methane concentrations of 0.1%v/v and maximum carbon dioxide concentrations of 0.9%v/v. Therefore, the site GSV was taken to be 0.0009l/hr, which is the worst case for methane and carbon dioxide. This GSV lies within the range of values designated for Characteristic Situation 1.

UXO

- 2.7.15 Stage 2 Detailed UXO Risk Assessment has been prepared by Brimstone Site Investigation Limited for the site (Report Ref: DRA-22-1433) which indicates that UXO poses a moderate risk to intrusive works.

**2.8 Remedial Appraisal**

Human Health

- 2.8.1 Localised contaminants of potential concern (CoPC) were recorded within the made ground materials when considering a public open space (residential) site end use setting. Notwithstanding this, it is understood that the entire site will be covered with hardstanding or within the footprint of the proposed structures, which will effectively mitigate the pollutant pathway. Should the proposed development layout change, a potential risk may be present and remedial measures may need to be incorporated to mitigate any potential risk.
- 2.8.2 Given the identified hydrocarbon impacted materials and potential for further hydrocarbon contamination associated with the former PFS infrastructure on site, further assessment may be required to determine the risk from vapours on site. Alternatively, vapour protection such as a hydrocarbon resistant membrane may be installed within the proposed development.
- 2.8.3 It is considered likely that the underground storage tanks (USTs) and any associated infrastructure will require decommissioning and removal as part of the proposed development works. Any such works should be undertaken by an appropriately qualified contractor. Although no evidence of significant hydrocarbon contamination has been recorded within this area to-date, it would be recommended that a watching brief is undertaken by a suitably experienced geoenvironmental consultant to confirm the presence or otherwise of any potential hydrocarbon contamination associated with the PFS infrastructure. Should any such contamination be identified, further assessment may be required to determine risks associated with any hydrocarbon impacted soils.
- 2.8.4 The potential for further USTs to be present at the site cannot be discounted. Should any such features be encountered during development works, site attendance by a suitably qualified geoenvironmental consultant would be recommended to assess for the presence of any contamination that may be associated with such features.

Controlled Waters

- 2.8.5 Given the identified contaminants of potential concern recorded within the underlying groundwater, a potential significant risk to controlled waters cannot be discounted. Notwithstanding this, it is understood that as part of the development works, the former PFS infrastructure will be removed, and it is considered that such works would likely provide gross contamination source removal and provide significant risk mitigation against the potential risk to controlled waters.
- 2.8.6 It is considered likely that a programme of groundwater monitoring will be required by the Environment Agency during and after the construction works.

Potential Sources of Ground Gas

- 2.8.7 The ground gas risk assessment indicated the site to be designated as Characteristic Situation 1 and therefore, no specific ground gas protection measures were considered necessary within the proposed buildings.

UXO

- 2.8.8 A moderate UXO risk has been identified for the site and, therefore, it will be necessary to clear each pile location via a CPT magnetometer survey.

### 3 FOUNDATION OPTIONS REVIEW

#### 3.1 Introduction

- 3.1.1 The proposed development is understood to comprise the construction of 534No. Purpose Built Student Accommodation units within a 28-storey building.
- 3.1.2 On the basis of the ground conditions identified within the exploratory holes, conventional foundations are not considered appropriate due to the potential loads associated with the proposed development and it is considered that a piled foundation solution would be the most appropriate founding method in this instance. In addition, the use of a ground bearing raft solution is also not considered feasible due to the potentially high column loads, the potential for excessive settlement and the need for tension piles to accommodate potential wind loading.
- 3.1.3 While full details have not been provided at this stage, as detailed on Shear Design Drawing titled “*General Arrangement: Pile Layout*”, referenced DSM-SDL-ZZ-FX-DR-ST-0001-P02, it is understood that piles are to be advanced to be socketed into the sandstone bedrock of the underlying Chester Formation with, at this preliminary stage, anticipated pile depths of between 8m and 13.5mbgl for bored load bearing piles and 12.5m and 15mbgl for contiguous piles. Piles of between 780mm and 1080mm diameter are proposed for the main structural piles and 610mm and 780mm for the contiguous piles.
- 3.1.4 Bored piles consist of drilling of an annulus which is infilled with wet concrete and a reinforcement cage inserted to the required depths. The existing ground materials will be removed from the shaft of the pile are likely to be disposed off-site.
- 3.1.5 The majority of the development will comprise either building footprint or hardstanding, with a new surface water drainage system installed which will further reduce the risk to controlled waters. Given the presence of a basement across much of the site, significant earthworks will be undertaken and previously unidentified mobile contamination to this depth will be appropriately removed from site, further reducing the risk to groundwater.

#### 3.2 Environment Agency Guidance

- 3.2.1 Environment Agency guidance on pollution prevention associated with piling and other ground improvement techniques is given in “Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination”, Report NC/99/73.
- 3.2.2 In accordance with the guidance, the following generic founding types are considered:
1. Displacement piles;
  2. Non-displacement piles; and
  3. Penetrative and non-penetrative ground improvement methods.

##### Non-displacement Piles

- 3.2.3 Suggested non-displacement piles for use on this site include:
1. Continuous flight auger (CFA) piles; and
  2. Bored and cased piles.

##### Displacement Piles

- 3.2.4 Suggested displacement piles for use on this site include:
1. Driven pre-cast displacement piles; and
  2. Driven cast-in-situ displacement piles.

Penetrative and Non-Penetrative Ground Improvement

- 3.2.5 Penetrative ground improvement techniques, such as stone columns, are not considered appropriate for the proposed structure, due to the type of the proposed structure (28 storey) together with anticipated design loads associated with the structure recorded. Therefore, this has not been considered further.

**3.3 Proposed Pile Options**

Non-displacement Piles - Continuous Flight Auger

- 3.3.1 Continuous Flight Auger (CFA) piles are a type of bored pile. However, due to the presence of rock at relatively shallow depths together with the size of some of the piles, it is considered that the use of CFA piles would be impractical and they have not been considered further in this assessment.

Non-displacement Piles - Conventional Rotary Bored / ODEX

- 3.3.2 Rotary bored piles are formed using a short flight auger to remove a column of soil and specialist tools to remove rock. If the hole requires support to remain open within made ground, for example, additional casing or, occasionally, support fluid, such as bentonite or polymer mud, can be used. A reinforcing cage is placed in the bore and concrete is then placed via a delivery tube or tremie
- 3.3.3 The term Odex is an abbreviation for Overburden Drilling EXcentric. Odex piling is a drilling method suitable for boring through boulders and rock strata and would be considered suitable here and involves a specialist heavy duty drill 'string' that is lowered into a steel outer casing. Once drilling starts, the Odex drill bit cuts ahead of the steel casing which enables a number of 'wings' on the bit to open out. The bit drills a hole with a diameter slightly greater than that of the steel casing. At the same time the 'shoulder' of the drill bit hits against a 'shoe' on the inside of the casing. This allows the steel casing to be hammered down simultaneously and closely behind the drill bit. High pressure air discharged through flushing holes in the face of the drill bit push the drill arisings back up the casing to the surface.
- 3.3.4 Once the desired depth has been reached, the drill bit is turned once in reverse; the 'wings' fold back in allowing the drill to be withdrawn back up inside the casing. The casing tube can either remain permanently or be removed after the concrete or grouting process has been completed.
- 3.3.5 The pile is then filled with concrete or grout after a reinforcement cage or solid bar is placed.
- 3.3.6 While the advantages of using a bored pile system are such that any obstructions within the made ground can more easily be overcome and there is much lower noise and negligible vibrations generated compared with driven pile types, bored piles are likely to be more expensive and slower to construct than other forms of piling. Further, while considered to be of low volume, potentially contaminated soil (made ground) may be generated using this technique which would require appropriate off-site disposal.

Displacement Piles - Driven Piles

- 3.3.7 Driven pre-formed piling involves the driving of pre-cast concrete or steel piles into the ground, displacing the ground beneath the pile laterally during driving. The two types of displacement piles (driven pre-formed piles and driven cast-in-place piles) are considered unlikely to be suitable for the development due to the required depth of pile as the recorded strength of the underlying Chester Formation and therefore have not been considered further in this assessment.

## 4 FOUNDATIONS WORKS RISK ASSESSMENT

### 4.1 Introduction

- 4.1.1 The Environment Agency has produced a methodology/guidance that identifies six potential pollutant linkage scenarios for different pile types. This provides a basis to determine the most appropriate pile type for the particular site-specific setting to ensure that a significant pollutant linkage will not be created. The following sections provide a detailed risk assessment (as described in Report NC/99/73: "Piling and penetrative ground improvement methods on land affected by contamination: Guidance on pollution prevention") in order to identify a pile type, which is unlikely to create a significant pollutant linkage.

### 4.2 Hazard Identification

- 4.2.1 The following potential adverse environmental impacts have been reviewed and assessed. [The reference to pollution scenario – is consistent with the EA Report NC/99/73].

*Pollution Scenario 1 - Creation of preferential pathways through a low permeability layer (an aquitard) to allow potential contamination of an aquifer.*

*Pollution Scenario 2 - Creation of preferential pathways, through a low permeability surface layer, to allow migration of landfill gas, soil gas or vapours to surface.*

*Pollution Scenario 3 - Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.*

*Pollution Scenario 4 - Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.*

*Pollution Scenario 5 - The driving of solid contaminants down into an aquifer during pile driving.*

*Pollution Scenario 6 - Contamination of groundwater, and subsequently, surface waters by wet concrete, cement paste or grout.*

### 4.3 Risk Assessment

- 4.3.1 With relevance to pile installation and this assessment, the contaminants identified within the made ground together with potential for hydrocarbon impacted soils are considered to be the main potential source of contamination, where elevated concentrations of heavy metals and total phenol have been identified.

- 4.3.2 In addition, groundwater samples were collected from the two deeper borehole monitoring wells and the following contaminants of potential concern (CoPC) were identified within the groundwater at the site:

- o PAH (naphthalene);
- o Total phenol (monohydric);
- o TPH-CWG Aromatic (EC5 – EC7); and
- o Benzene.

- 4.3.3 In addition, a number of VOC and SVOC concentrations were detected above the minimum detection limit within the groundwater, including VOC's: BTEX, Isopropylbenzene, n-Propylbenzene and 1,3,5-Trimethylbenzene and SVOC's: Aniline, 2,4-Dimethylphenol and 2-Metylnaphthalene.

- 4.3.4 Based on the limited groundwater monitoring undertaken to-date, the leachable heavy metals identified within the made ground were not detected at significant concentrations within the sampled groundwater and therefore may not pose a risk to the identified controlled water receptors.

- 4.3.5 The Environment Agency guidance identifies the following indicative hazards associated with various piling and penetrative ground improvement methods. However, as indicated in the previous section, penetrative ground improvement techniques are not considered appropriate for the proposed structure and, therefore, have not been considered further.

- 4.3.6 References to risk estimations are made in accordance with the methodology presented in CIRIA publication C552 (2001) titled 'Contaminated Land Risk Assessment: A Guide to Good Practice'.

*Non-displacement Piles - Conventional Rotary Bored*

*Scenario 1 - Creation of permeable pathways*

- 4.3.7 The bore cased non-displacement pile will provide a method of drilling without the creation of a short-term pathway down the void created to construct the pile. The pile column will be constructed from the base of the hole upwards as the casing is withdrawn (or sacrificed). In some circumstances, this non-displacement method can reduce the density of the soils adjacent to the pile where coarse materials are encountered, which may create a long-term pathway through the made ground. However, based on the results of the intrusive investigations to-date, the probability of this occurring is considered to be unlikely.
- 4.3.8 As the underlying geology is classified by the Environment Agency as Secondary A and Principal Aquifers and the close proximity of the River Medlock and Castlefield Canal Basin, the consequence of vertical migration of contaminated water is considered as severe.
- 4.3.9 The load-bearing piles will be within the footprint of the proposed building and will benefit from the presence of the basement floor slab together with the proposed drainage system, which will act to significantly reduce water infiltration and will reduce the possibility of contaminated water generated from the remaining made ground and potentially impacted soils/rocks reaching these piles. However, the propped contiguous piles along the boundaries would not benefit from the effects of the proposed slab and drainage system.
- 4.3.10 The made ground is already in continuity with underlying more granular strata, therefore no new pathways are considered to be created when using this method.
- 4.3.11 As a result, the risk is considered to be low.

*Scenario 2 - Migration of Ground Gas/Vapours*

- 4.3.12 If the casing is to be removed, casting of the pile in-situ will create an intimate contact between pile shaft and soils and, therefore, likely to remove the pathway temporarily created by the construction of the void into which the pile concrete is cast. However, if the casing is to be sacrificial the pile will not form an intimate contact with any made ground or previously unidentified contamination, which may include hard objects, thus potentially creating a pathway.
- 4.3.13 Following the ground gas assessment undertaken as part of the Ground Investigation Report by TEC (ref: 2006023.001.01A), the general site area has been characterised as Characteristic Situation 1 in accordance with the Revised Wilson and Card Classification detailed within CIRIA C665 (for developments other than low rise housing).
- 4.3.14 Therefore, while the consequence is considered to be potentially severe, the probability is considered to be low to negligible.
- 4.3.15 As a result, the risk is considered to be low.

*Scenario 3 - Direct Contact of Site Workers and Others with Contaminated Soil Arisings*

- 4.3.16 The pile hole construction technique will result in arisings of potentially contaminated soil being generated. These materials will potentially create a risk to construction workers and other site users who may come into contact with the spoil, including potentially hydrocarbon impacted soils and rock. As a consequence, good brownfield site working practices should be adopted by construction workers to mitigate against the potential risks, including the use of appropriate PPE. The arisings will be subject to Hazardous Waste Regulations and will require appropriate off-site disposal.
- 4.3.17 The probability is considered highly likely and its consequence is considered to be mild, although with good brownfield practices this may be considered to be low.
- 4.3.18 As a result, the risk is considered to be low/moderate.

*Scenario 4 - Degradation of Pile Materials*

- 4.3.19 The pile will be in direct contact with any made ground or previously unidentified contamination and any associated perched water.
- 4.3.20 The piles will be constructed to prevent aggressive chemical environments from impacting the integrity of the pile and creating a pathway in the context of Scenarios 1 and 2. Where a sacrificial casing is not used, it is highly likely that the pile will come into contact with aggressive chemicals. However, if an appropriate design concrete design mix is used the consequence would be negligible / minor.
- 4.3.21 As a result, the risk is considered to be low.

*Scenario 5 - Driving Down Solid Contaminants*

- 4.3.22 The boring technique removes soil from the base of the hole, resulting in arisings at the surface and may not drive contaminants into the ground. Further, quantities of made ground remaining within the casing at the end of the rotary element are considered to be negligible.
- 4.3.23 However, where casing is driven behind the ODEX head, minor quantities of made ground materials may be carried down as the drilling progresses. Further, research undertaken by the University of Sheffield on behalf of the Environment Agency and English Heritage ("Piling in layered ground: risks to groundwater and archaeology", ref: SC020074/SR, dated September 2006) indicates that even when considering driven piles vertical displacements typically were recorded to extend up to 1.5 pile diameters from the centreline of a cylindrical pile, but were mostly concentrated within a radius of one pile diameter.
- 4.3.24 Consequently, while it is recognised that there is the potential for some minor quantities of the made ground material / hydrocarbon impacted soils or previously unidentified contamination to be taken into the underlying materials, its effect is considered to be of minimal environmental impact and therefore the consequence is considered to be mild, while the probability has been determined as low likelihood, although the consequence of driving potentially contaminated material into the underlying aquifer is considered as medium to severe.
- 4.3.25 As a result, the risk is considered to be low.

*Scenario 6 - Contamination of Groundwater by Concrete, Cement Paste or Grout*

- 4.3.26 The concrete forming a bored pile is likely to be tremied to the toe of the bore with the pile being formed as the casing is withdrawn and concrete injection continues. The injection of concrete into the hole presents a risk of contamination of groundwater; however, the risk is low as the concrete should only be filling the void formed by the boring process.
- 4.3.27 Therefore, it is considered that the potential is unlikely while the consequence to the aquifer is considered to be medium for this scenario.
- 4.3.28 As a result, the risk is considered to be low.

**4.4 Summary**

- 4.4.1 The guidance provides indicative hazards for each intrusive founding method. However, the following table indicates the potential for migration pathway creation due to piling, where, following the CIRIA publication C552, the Probability (P) ranges from negligible (0) Unlikely (1), Low likelihood (2), Likely (3) and Highly Likely (4), and the Consequence (C) ranges from Minor (1), Mild (2), Medium (3) and Severe (4).
- 4.4.2 The degree of risk is calculated by multiplying the likelihood by the effect, which are summarised in Table 4.1 overleaf.

Table 4.1: Risk Assessment Summary

| Pile Type                        | Scenario 1 |   |   | Scenario 2 |   |   | Scenario 3 |   |   | Scenario 4 |   |   | Scenario 5 |   |   | Scenario 6 |   |   | Risk Score/ Overall Risk Descriptor |
|----------------------------------|------------|---|---|------------|---|---|------------|---|---|------------|---|---|------------|---|---|------------|---|---|-------------------------------------|
|                                  | P          | C | R | P          | C | R | P          | C | R | P          | C | R | P          | C | R | P          | C | R |                                     |
| Continuous flight auger (CFA)    |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   | N/A                                 |
| ODEX and drive                   | 1          | 4 | 4 | 1          | 4 | 4 | 4          | 2 | 8 | 3          | 1 | 3 | 2          | 3 | 6 | 1          | 3 | 3 | 28 / Low to Moderate Risk           |
| Bored and cased pile             | 1          | 4 | 4 | 1          | 4 | 4 | 4          | 2 | 8 | 3          | 1 | 3 | 1          | 3 | 3 | 1          | 3 | 3 | 25 / Low to Moderate Risk           |
| Driven pre-cast displacement     |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   | N/A                                 |
| Driven cast-in-situ displacement |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   |            |   |   | N/A                                 |

#### **4.5 Conclusions of Risk Assessment**

- 4.5.1 On the basis of the foundation works risk assessment and the existing site conceptualisation in relation to the proposed development, the potential risks associated with each potential pile type is generally considered to be of low to moderate risk and at this stage, the use of conventional rotary or ODEX/drive piles is considered most appropriate for the proposed development.
- 4.5.2 The site-specific conceptual model indicates there to be a low to moderate risk that rotary piles would create a new pathway for contamination migration from the made ground into the underlying aquifer than is already present. Furthermore, any short-term pathways created by the piling are considered to represent a relatively low risk to the wider environment within the context of the current situation at the site.
- 4.5.3 While the use of rotary piles will result in the generation in arisings of possibly contaminated materials, it should be noted that mitigation measures for the appropriate disposal of generated contaminated horizons are to be implemented on site and therefore, the risk from direct contact of site workers and others with contaminated soil arisings that have been brought to the surface is low, where good brownfield practices are implemented.
- 4.5.4 Vertical displacement of materials during the advancement of conventional rotary boreholes is generally considered to be negligible / unlikely. Notwithstanding this a marginally greater risk is considered for an ODEX and drive pile.

## **5 RISK MITIGATION**

### **5.1 General**

5.1.1 While it will be necessary for appropriate quality control and quality assurance measures to be enforced during all piling operations to ensure the minimum risk to the environment results from the piling works. Due to the generally low risk at the site, the use of specific mitigation measures is not considered necessary in respect of controlled waters, site end users and construction workers above any beyond what will already be employed to enable site works and ensure the development is suitable for the intended use.

5.1.2 Notwithstanding this, it is recognised that there is the potential for some of the made ground material or previously unidentified contamination to be taken into the underlying materials, and while its effect is considered to be of minimal environmental impact, given the potential severe consequence should contaminated materials migrate into the underlying aquifer, it is recommended that a pro-active approach is adopted through a programme of regular groundwater quality monitoring. This should be undertaken during and after the piling and basement excavation to ensure the inclusion of the proposed piles and the formation of the basement has not resulted in the deterioration of groundwater quality from those of the established baseline conditions.

### **5.2 Recommendations**

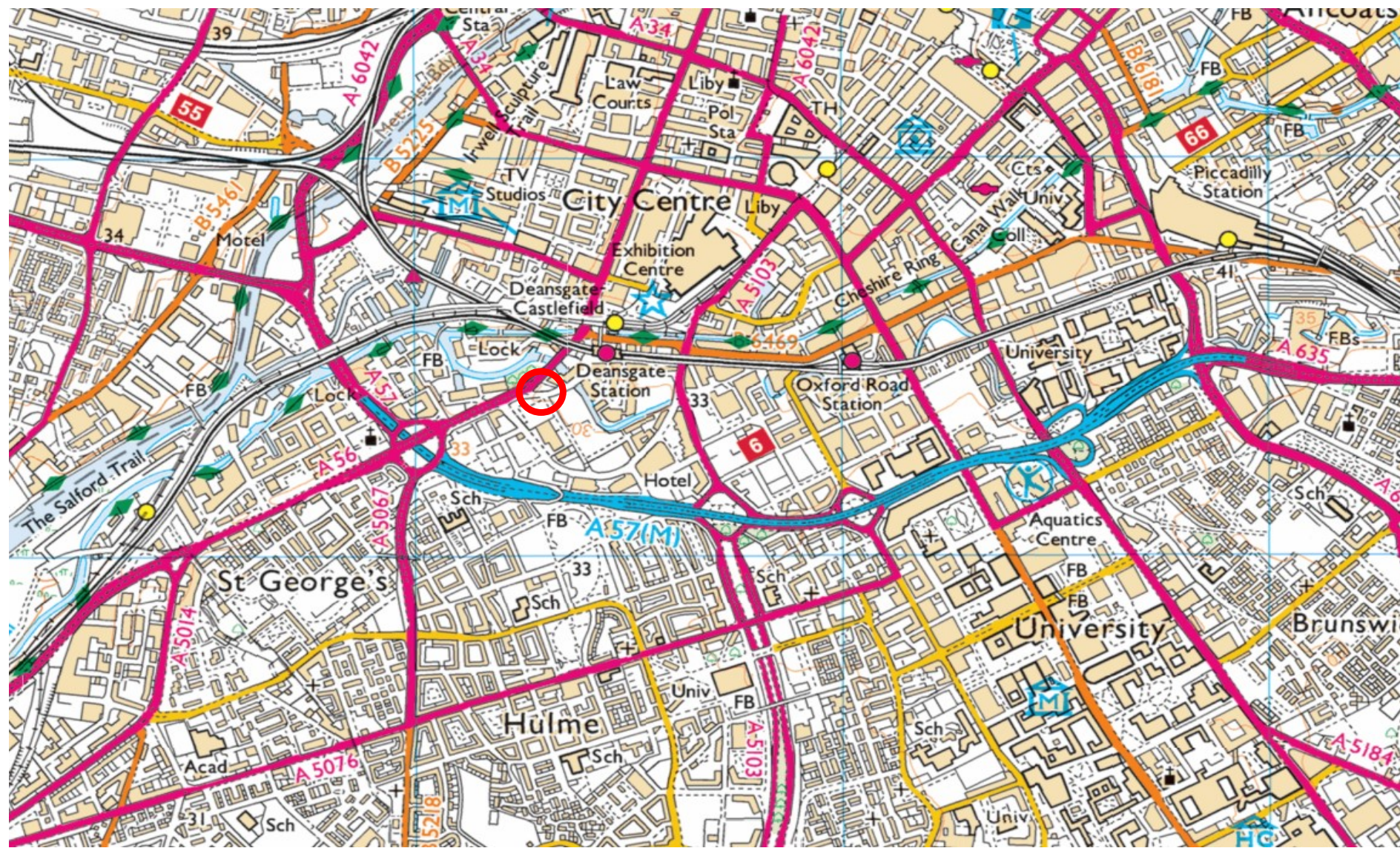
5.2.1 A programme of regular groundwater quality monitoring will be required. This should be undertaken during and after the piling and basement excavation to ensure the inclusion of the proposed piles and the formation of the basement has not resulted in the deterioration of groundwater quality from those of the established baseline conditions.

5.2.2 Stage 2 Detailed UXO Risk Assessment has been prepared by Brimstone Site Investigation Limited for the site (Report Ref: DRA-22-1433) which indicates that UXO poses a moderate risk to intrusive works and, therefore, it will be necessary to clear each pile location via a CPT magnetometer survey.

5.2.3 Should contamination be found at any time when carrying out the development that was not previously identified, an investigation and risk assessment may be needed, which may require this Foundation Risk Assessment to be reviewed and up-dated.

**TEC**

## Figures and Drawings



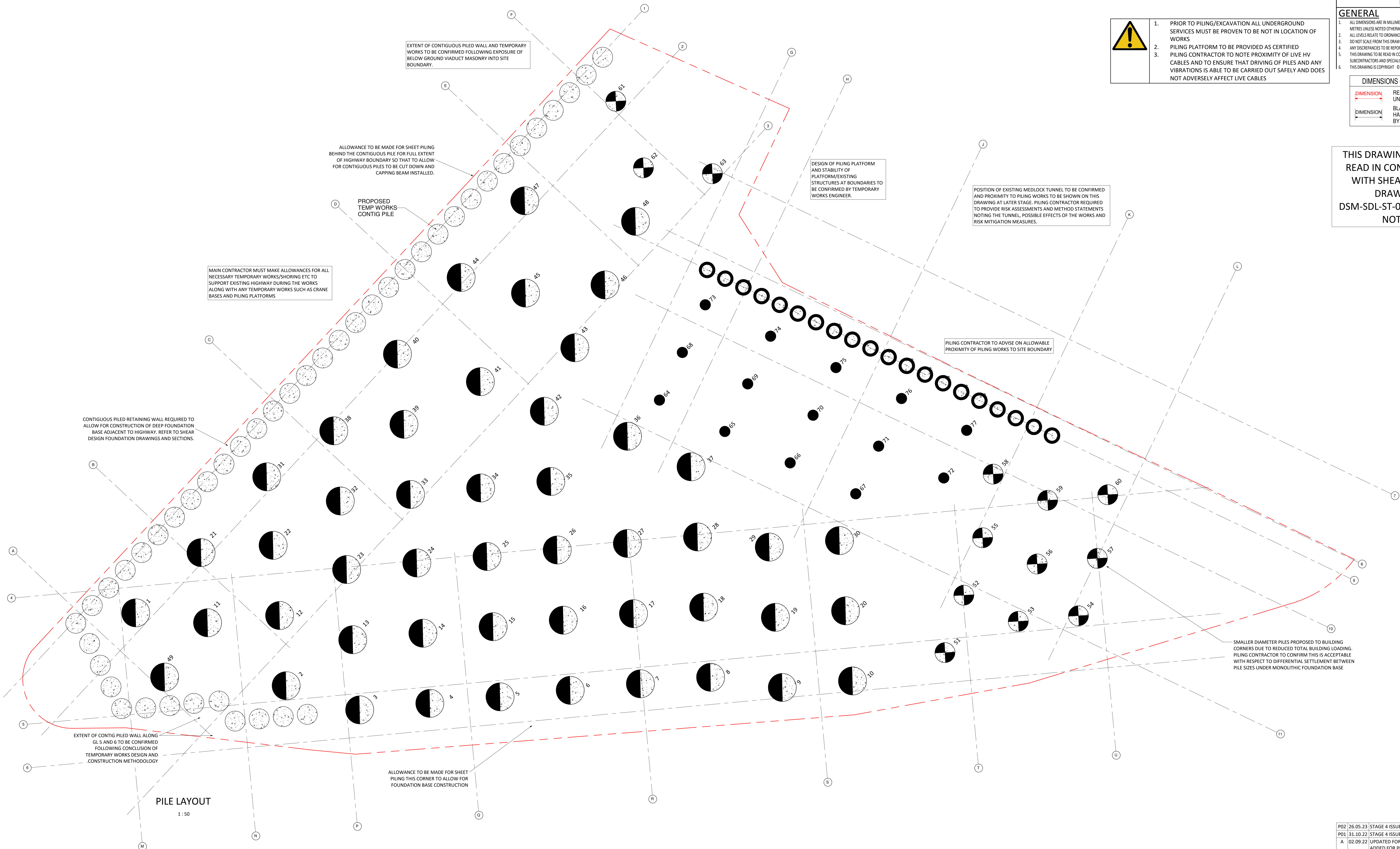
Approximate Site Location: 

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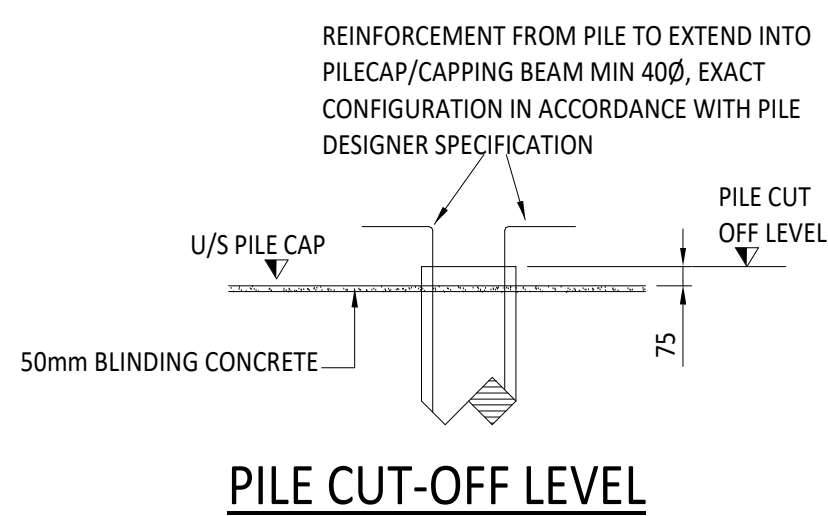
|                                                                                     |                                                                      |                                                                      |                                         |                                         |                                                 |                                |                     |                        |                   |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------------|-----------------------------------------|-------------------------------------------------|--------------------------------|---------------------|------------------------|-------------------|
|  | TEC<br>The Old Chapel<br>35a Southover<br>Wells, Somerset<br>BAS 1UH | Tel: 01749 677760<br>Email: info@tecon.co.uk<br>Web: www.tecon.co.uk | Site Name:<br><br>Deansgate, Manchester | Drawing Name:<br><br>Site Location Plan | Client Name:<br><br>Fusion Manchester Devco Ltd | Project No:<br><br>2006023.002 | Figure No:<br><br>1 | Date:<br><br>July 2023 | Scale:<br><br>NTS |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------------|-----------------------------------------|-------------------------------------------------|--------------------------------|---------------------|------------------------|-------------------|



Scale:  
NTS



PILE LAYOUT  
1:50



PILE CUT-OFF LEVEL

| PILE DIAMETERS / LENGTHS AND LOADINGS* |                 |           |                 |                  |                                                                                                              |                   |                    |                  |
|----------------------------------------|-----------------|-----------|-----------------|------------------|--------------------------------------------------------------------------------------------------------------|-------------------|--------------------|------------------|
| PILE                                   | DIAMETER (mm)   | NUMBER    | COMPRESSION SWL | NET TENSION (kN) | HORIZONTAL                                                                                                   | DESIGN LENGTH (m) | CROPPED LENGTH (m) | TOTAL LENGTH (m) |
|                                        | 1050            | 48 APPROX | 7500kN          | 1500             | 250kN                                                                                                        | 11                | 3                  | 14               |
|                                        | 750             | 15        | 4000kN          | 300              | 100kN                                                                                                        | 11                | 2.25               | 13.25            |
|                                        | 750 CONTIG WALL | 25 APPROX | 2600kN/m        | --               | 20kN/m <sup>2</sup> HIGHWAY SURCHARGE (15MM DEFLECTION) REFER TO GEOTECHNICAL DATA FOR EARTH/WATER PRESSURES | TBC               | TBC                | TBC              |
|                                        | 600 CONTIG WALL | 20 APPROX | 2200kN/m        | --               | 20kN/m <sup>2</sup> HIGHWAY SURCHARGE (15MM DEFLECTION)                                                      | TBC               | TBC                | TBC              |
|                                        | 400             | 14 APPROX | 1500kN/m        | --               | TBC                                                                                                          | TBC               | TBC                | TBC              |

\* BASED ON PRELIMINARY ADVICE FROM GEOTECHNICAL ENGINEER AND SHALL NEED TO BE CONFIRMED BY DETAILED SPECIALIST PILING DESIGN.  
BUILDING PILES TO BE DESIGNED AS FIXED HEAD.  
SPECIALIST DESIGN TO TAKE INTO ACCOUNT EFFECTS OF NEGATIVE SKIN FRICTION AND DOWNDRAG.  
PILING SPECIALIST TO PROVIDE DESIGN WITHOUT A LOAD TEST REQUIRED.  
100% INTEGRITY TESTING TO BE PROVIDED.  
NET TENSION INDICATES THE TENSION LOADING IN THE PILES AFTER THE CONSIDERATION OF FAVOURABLE VERTICAL LOADINGS AND IS THE SLS TENSION FORCE THAT THE PILES AND REINFORCEMENT NEED TO BE DESIGNED FOR.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TOWER CRANE BASE</b><br>DRAWING HAS BEEN PRODUCED IN ADVANCE OF ANY CRANE AND CRANE BASE INFORMATION. LOCATION OF CRANE BASE IS TO BE CONFIRMED, DESIGNED BY TEMPORARY WORKS ENGINEER, AND DRAWING SHALL BE UPDATED TO INCORPORATE TEMPORARY WORKS AS REQUIRED.                                                                                                                                                                               | <b>UNEXPLODED ORDNANCE</b><br>DETAILED UXO REPORT HAS CONFIRMED SITE IS A MODERATE UXO RISK SITE. ALLOWANCE TO BE MADE FOR SITE BRIEFING, SUPERVISION DURING EXCAVATION WORKS AND PRE-PROBING OF PILE LOCATIONS. REFER TO DETAILED REPORT. |
| <b>TEMPORARY WORKS</b><br>CONTRACTOR(S) TO ALLOW FOR FULL DESIGN AND INSTALLATION FOR ALL TEMPORARY WORKS ITEMS INCLUDING ANY TEMPORARY RETAINING/SHORING OF SITE BOUNDARIES (HIGHWAYS) AND TOWER CRANE (INCL BASES).                                                                                                                                                                                                                            | <b>SITE INVESTIGATION</b><br>THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT GROUND INVESTIGATION REPORTS AND THEIR RECOMMENDATIONS AND REQUIREMENTS.                                                                          |
| <b>PILING DESIGN AND MATERIALS</b><br>FULL DESIGN OF PILED FOUNDATIONS TO BE PROVIDED BY SPECIALIST. DESIGN TO INCLUDE MINIMUM PILE REINFORCEMENT REQUIREMENTS AND ANCHORAGE INTO MAIN BUILDING FOUNDATIONS.<br>DESIGNER TO MAKE THEMSELVES AWARE OF PROPOSED FOUNDATIONS PROPOSALS AND CUT OFF LEVELS AS A RESULT OF DEEP FOUNDATIONS CAPS.<br>PILING DESIGNER TO ALLOW FOR CONCRETE MIX TO SUIT BELOW GROUND CONDITIONS INCLUDING ACIDS CLASS. | <b>BELOW GROUND SERVICES</b><br>CONTRACTOR SHOULD REFER TO EXISTING BELOW GROUND SERVICES INFORMATION.                                                                                                                                     |
| <b>PROTECTION OF GROUNDWATER</b><br>PILING CONTRACTOR TO REVIEW PLANNING REQUIREMENT FOR THE PROTECTION OF BELOW GROUND WATERS FROM CONTAMINATION DURING THE PILING WORKS.<br>CONTRACTOR TO ALLOW FOR PRE-CASED CONSTRUCTION AND BENTONITE PLUGS TO PREVENT CROSS CONTAMINATION FROM UPPER MADE GROUND LEVELS INTO GROUND WATER BELOW. SUBJECT TO RECEIPT OF FULL SITE INVESTIGATION.                                                            | <b>VIBRATION/MONITORING</b><br>ALLOWANCE TO BE MADE FOR VIBRATION/MONITORING DURING THE PILING WORKS SUBJECT TO FINAL REQUIREMENTS FOR PROXIMITY MEDLOCK TUNNEL.                                                                           |

DRAWING FOR STAGE 4 DESIGN AND INITIAL COSTING PURPOSES ONLY. EXACT SETTING OUT AND DESIGN LENGTH OF PILES TO BE CONFIRMED AT NEXT DESIGN STAGE. DRAWING NOT FOR CONSTRUCTION.

PILE ARRANGEMENT, SIZES AND LENGTHS BASED ON INITIAL ADVICE FROM GEOTECHNICAL CONSULTANT AND PILING SPECIALISTS. EXACT ARRANGEMENT TO BE CONFIRMED WITH FINAL DESIGNER FOLLOWING RECEIPT OF FULL SITE INVESTIGATION



1. PRIOR TO PILING/EXCAVATION ALL UNDERGROUND SERVICES MUST BE PROVEN TO BE NOT IN LOCATION OF WORKS
2. PILING PLATFORM TO BE PROVIDED AS CERTIFIED
3. PILING CONTRACTOR TO NOTE PROXIMITY OF LIVE HV CABLES AND TO ENSURE THAT DRIVING OF PILES AND ANY VIBRATIONS IS ABLE TO BE CARRIED OUT SAFELY AND DOES NOT ADVERSELY AFFECT LIVE CABLES

#### NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS RELATE TO ORDNANCE DATUM UNLESS NOTED OTHERWISE.
3. DO NOT SCALE FROM THIS DRAWING. USE FIGURED DIMENSIONS ONLY.
4. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
5. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
6. THIS DRAWING IS COPYRIGHT © PROPERTY OF SHEAR DESIGN LIMITED.

#### DIMENSIONS COLOUR KEY

|  |                                                  |
|--|--------------------------------------------------|
|  | RED DIMENSIONS ARE UNVERIFIED                    |
|  | BLACK DIMENSIONS HAVE BEEN VERIFIED BY ARCHITECT |

THIS DRAWING MUST BE READ IN CONJUNCTION WITH SHEAR DESIGN DRAWING DSM-SDL-ST-0080 FOR ALL NOTES

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|-----|----------|-----------------------------------------------------------------------------------------------------------------------------|----|-----|
| PO2 | 26.05.23 | STAGE 4 ISSUE                                                                                                               | AK | BGH |
| P01 | 31.10.22 | STAGE 4 ISSUE                                                                                                               | DF | BGH |
| A   | 02.09.22 | UPDATED FOR STAGE 3+ ISSUE. NOTE ADDED FOR PROTECTION OF BELOW GROUND WATERS AND MONITORING FOR PROXIMITY TO MEDLOCK TUNNEL | BG | BGH |
| REV | DATE     | DESCRIPTION                                                                                                                 | BY | CHK |

#### Revision Schedule

|          |                                      |
|----------|--------------------------------------|
| CLIENT:  | FUSION MANCHESTER DEVCO LIMITED      |
| PROJECT: | DEANSGATE SOUTH DEANSGATE MANCHESTER |
| TITLE:   | GENERAL ARRANGEMENT PILE LAYOUT      |

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|--------|----|----------|----|-------|----------|--------|-----------------|
| DRAWN: | AK | CHECKED: | BH | DATE: | 23/07/22 | SCALE: | As Indicated@A0 |
|--------|----|----------|----|-------|----------|--------|-----------------|

STATUS: **STAGE 4**

|                   |       |                 |                          |           |     |
|-------------------|-------|-----------------|--------------------------|-----------|-----|
| SHEAR DESIGN REF: | 20047 | DRAWING NUMBER: | DSM-SDL-ZZ-FX-DR-ST-0001 | REVISION: | PO2 |
|-------------------|-------|-----------------|--------------------------|-----------|-----|

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