

Etihad Campus – Site Improvement Works

Groundwater Risk Assessment

ETC-BHE-ZX-XX-RP-CG-0004

0053810

24 February 2023

Revision P01

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author **Francesca Gould**

date **24th February 2023**

approved **Hugh Mallett / Chris O'Hara**

signature



date **24th February 2023**

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1 Introduction

1.1 Background and commission

It is proposed to undertake grouting works beneath the pile bases underlying the Etihad Campus site to provide efficiencies in the pile design. A geoenvironmental Generic Quantitative Risk Assessment (ETC-BHE-ZX-XX-RP-CG-0003) [1], Preliminary Risk Assessment (ETC-BHE-ZX-XX-RP-CG-0001) [2], and a Coal Mining Risk Assessment (ETC-BHE-ZX-XX-RP-CG-0002) [3] have all been prepared with respect to the proposed site improvement works. However, they do not specifically consider the risk to groundwater associated with the proposed grouting operations. Accordingly, this report has been prepared to assess those potential risks. It takes account of all of the information in the above reports and has been prepared in accordance with guidance provided in the Environment Agency Regulatory Position Statement (RPS 108) [4] and by CIRIA (in particular Chapter 13) [5].

1.2 Aims and objectives

The overall aim of this assessment is to ensure that the proposed grout works (which include injection below the water table), will not have a detrimental impact on controlled waters (the groundwater regime in the Coal Measures) and the nearby surface waters (River Medlock and Ashton Canal). The specific objectives of this report are addressed in two Parts in the following text:

Part A

1. To review and summarise data with respect to the Site's conceptual site model, including mining (Section 2);
2. To describe the proposals for grouting (Section 3); and
3. To carry out a risk assessment and identify appropriate mitigation measures (Section 4 and Table 1).

Part B

1. To provide a direct response to the 'Our Approach' section set out by the EA in the Regulatory Position Statement (RPS) 108 – Grouting Media; and
2. To address the 'Appropriate Assessment Record' as set out by the EA in Appendix 1 of the RPS 108.

This text is supported by Drawings (referred to in the text) and by particular information presented Appendix A – Groundwater Level Monitoring Proposal.

2 Part A – Conceptual Site Model

2.1 Geology

2.2 Summary of mining (coal seams and mine shafts)

The type of mine working that has taken place on Site is coal mining associated with Bradford Colliery. Bradford Colliery was formerly located to the southeast of the Site, beyond the current Stadium.

2.2.1 Coal seams

The cluster of productive seams that sub-crop across the wider Sportcity area include: Openshaw Mine, Charlotte Mine, Three Quarters Mine and Bradford Four-foot Mine. The seams in this group were separated by bands of shale and fireclay. Situated at a depth of about 509 yards (465m) the Bradford Four-foot Mine is the deepest and thickest of these seams (depth assumed to be from Bradford Colliery, seam sub-crops to the north and east of the Site). Below the Bradford Group are the Parker Mine, Crombouke Mine and Roger Mine. The insets to the Parker and Roger Mines are at depths of about 543 yards (496m) and 946 yards (865m) respectively. The Crombouke Mine is 26 yards (24m) above the Roger Mine.

In the early 1870s fireclay (used to manufacture bricks) was exploited from some of the shallow workings, including the Openshaw. Fireclay workings were abandoned in 1903. The shallow / outcropping seams from the Bradford sequence were apparently worked at a very early date from a series of shafts accessing the coals close to the sub-crop. Shallow mine workings of similar (early) date were also present within the Charlotte Mine, and it is these workings along with the Openshaw seam that sub-crop at the Site. In addition to the main seams recorded (as detailed above) a series of thinner seams have also been recorded by Arup [1]. These thinner seams are recorded to sub-crop between the Charlotte seams and the Bradford Three Quarter and are named as Thin Coal A, Thin Coal B and Thin Coal C. The recent ground investigation completed by Geotechnical Engineering Ltd confirmed the presence of the Openshaw, the Charlotte Seams (upper and lower bands) and the Thin A and Thin B seams. On all occasions the coal was recorded as intact.

As part of the development of the Stadium, grout works were concentrated around the Charlotte Coals and the Openshaw. No grout records have been made available for review in respect of the main works undertaken below and in the immediate vicinity of the stadium. However, a plan showing the grouting grid has been reviewed, and this appears to show a 6m grout grid pattern reducing locally to 3m in areas. It is assumed that the grid pattern was locally reduced to 3m as a result of increased grout take suggesting the potential for voids having been encountered in these areas. Other areas surrounding the Site were also subject to grouting (i.e. IMC Metrolink, BWB validation works) the records of which are presented in detail within the Coal Mining Risk Assessment [2]. No significant grout takes were recorded during these works.

2.2.2 Mine shafts

The nearest shafts located to the Site are those to the north and northeast, Shaft F, Shaft G, Shaft I and Shaft H, see Drawing ETC-BHE-ZX-XX-DR-CG-2002. A summary of these shafts is presented in Table 1 along with the treatment details.

Table 1 Mine shafts within close proximity to the Site

Shaft Ref	Coal Auth. Ref.	National Grid Ref	Location	Shaft description	Treatment details
F	386398-005	386797, 398757	Located south of the Metrolink Corridor, north of the Site.	2.4m diameter with two courses of brick lining and covered by a concrete slab. Proved to 80m, close to expected depth of Bradford Four-foot Coal.	Coal Authority (CA) record the shaft was pressure grouted to a depth of 40m with 25.5tonnes of grout by contractors on behalf of Amec Capitol Projects Ltd. Shaft backfill pressure grouted as part of Metrolink Advance Works Contract. Grout injected under pressure until constant pressure was maintained indicating limit of grout take, process repeated until casing was at 20m and grout at the surface. Total grout take was 23 tonnes. No cap constructed.
G	386398-006	386847, 398773	Located south of the Metrolink Corridor, northeast of the Site.	-	Shaft backfill pressure grouted as part of the Metrolink Advance Works Contract. Borehole drilled, 75mm casing installed to 40m depth. In total 23 tonnes of grout injected under pressure at 40m depth. Process repeated in stages until 10m depth. Total grout take for shaft was 25.5 tonnes.
H	386398-013	386882, 398758 BH1: 386891.7, 398742.3	No primary source other than CA to show the shaft at this location.	Shaft location investigated during Metrolink and Stadium enabling works and not located. In 2010 a total of 150 probe holes were drilled in a spiral pattern at 1.5m centres to explore the position of the shaft. Shaft potentially located during the 2020 CCG ground investigation whereby 42m of Made Ground (with low SPT results) was encountered within the BH1 location (some 20m south).	No details, investigated but not located, based on historic plans conjectured position is NE of Shaft I, as Shaft I was identified this would suggest Shaft H is beneath the Metrolink land; however, if the 42m of made ground encountered by CCG in 2020 is in fact the location of Shaft H, it would place it approximately 10m east of the Site as shown in drawing ETC-BHE-ZX-XX-DR-CG-2002.
I	386398-012	386919, 398782	Located to the south of the Metrolink, northeast of the Site.	Shaft located, 2.3m diameter with two courses of brick lining. Proven to 51m, close to the expected depth of the Bradford Four-foot seam	Shaft was pressure grouted in October 3001 for Amec Capitol Projects Ltd. Borehole drilled, 75mm casing installed to 40m depth. 20 tonnes of grout injected under pressure at 40m depth. Doesn't confirm the depth of the shaft. Total grout take was 31 tonnes.

As noted in Table 1 above, CCG undertook a ground investigation in 2020 in connection with the proposed construction of a deep shaft (sewerage) off Alan Turing Way. The scope of the investigation comprised the sinking of 4no. boreholes (BH1 to BH4, inclusive) by cable percussion methods. Borehole 1 (NGR 386891.7, 398742.3) discovered 42m of Made Ground in close proximity to the previously unknown location of Shaft H mentioned in Table 1. It is thought this is either Shaft H or another unrecorded shaft as there is no previous Coal Authority reference for this location. Notwithstanding this information, further unrecorded mine entries within or nearby to the Site (that do not appear on the Coal Authority records) cannot be discounted.

All mine shaft locations including the location of BH1 from the 2020 CCG ground investigation have been plotted on a Site plan, shown on Drawing ETC-BHE-ZX-XX-DR-CG-2002. Many plans do not include co-ordinated positions of the shaft locations and therefore have been inferred based on unchanged features i.e. Ashton Canal. The precise location of these inferred positions cannot be relied upon and should be treated as approximations.

2.3 Summary of site investigation

A ground investigation was completed by Geotechnical Engineering Ltd in December 2022 with a programme of monitoring continuing into February 2023. The investigation included 8no. boreholes using cable percussion methods with rotary core follow-on. The boreholes were drilled down to depths of between 45m and 65mbgl. A series of cross sections have been developed (see Drawings ETC-BHE-ZX-XX-DR-CG-3002 - 3004) that illustrate the extent and thickness of the shallow geology and various coal seams encountered through the Coal Measures. Groundwater levels are also shown within these sections.

Made Ground was encountered typically down to 5mbgl, followed by approximately 11m of Glacial Till and rockhead of the Coal Measures between 15m and 17.7mbgl (+44 to +45mOD). Groundwater level ranges between +38m and +41mOD.

There were no voids or significantly broken ground encountered during the ground investigation. Localised areas did encounter some fracturing to the bedrock. The Rock Quality Density (RQD) was inspected through the Coal Measure strata, this is a measure of solid core greater than 100mm (i.e. no fractures) presented as a percentage. Where the RQD values were <50% these zones generally corresponded with the depths at which the drill flush was lost during drilling, see below Table 2 for a summary of these findings.

Table 2 Summary of flush loss and areas where RQD was <50% within those areas

Borehole ID	Depth of flush loss during drilling	RQD <50% at the zone of flush loss
BH22/01	No flush loss	N/A
BH22/02	48.0m (+12.5mOD)	+14.0 to +12.5
BH22/03	43.5m (+17.3mOD)	+14.3 to +10.6
BH22/04	34.7 (+25.9mOD)	+25.9 to +24.4 +22.9 to +21.4
BH22/05	24.0 (+37.0mOD)	+39.8 to +33.8 +30.8 to +26.3
BH22/06A	36.2 (+24.4mOD)	+24.4 to +13.9
BH22/07	33.0 (+28.0mOD)	+29.5 to +28.0 +26.5 to +23.5
BH22/08	No flush loss	N/A

A six-week programme of groundwater monitoring was carried out following the intrusive ground investigation. Details of this monitoring can be found within the Generic Quantitative Risk Assessment Report [3]. The groundwater levels have been summarised below in Figure 1 with the distribution shown in Drawing ETC-BHE-ZX-XX-DR-CG-1009. Localised shallow perched groundwater was occasionally encountered at various depths within the Made Ground. The Coal Measures groundwater table is between +37.7mOD and +42.0mOD (i.e. greater than 20m below current ground levels). The groundwater flow direction was reported to be in a westerly direction [4], towards the River Medlock. However, the recent ground investigation data [refer to Drawing ETC-BHE-ZX-XX-DR-CG-1009] appears to indicate groundwater may flow towards the east / south-east.

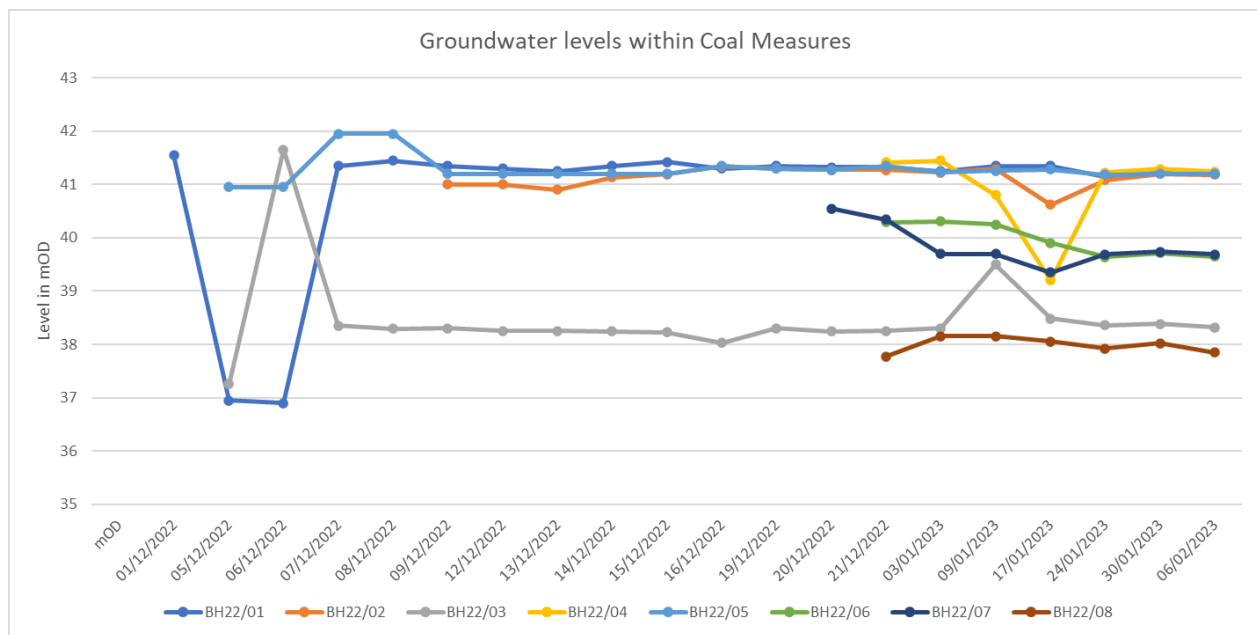


Figure 1 Groundwater monitoring results from Coal Measures

3 Part A – Grouting Proposal

3.1 General

The full detailed grouting proposal has not yet been produced as the specialist contractor is yet to be appointed. The following proposals are anticipated:

3.1.1 Treatment objectives

The Site is currently public open land generally covered by hardstanding at a ground level of approximately +59mOD. The objective of the site improvement works is to grout areas beneath potential future pile bases within the Coal Measures which may be influenced by the historical coal mining within the area. This will assist in reducing the risk of self-weight collapse settlement and facilitate a more economic pile design scheme.

3.1.2 Grout treatment proposals

It is currently envisaged that the works will penetrate to a depth of ~30m BGL. It should be noted that as part of the GEL 2022 ground investigation, no voids were recorded during drilling. However, fractured zones of rock along with flush loss during the drilling process were recorded (see Table 2).

A summary of the current proposal is provided below:

- The Site will be probed to determine the area requiring treatment;
- The grouting grid will be determined by the conditions encountered on Site. The envisaged primary grid will likely be 6m x 6m, a secondary offset grid of 6m x 6m and the potential requirement for subsequent tertiary 3m x 3m grid subject to grout takes;
- Sequencing will be a consideration due to existing Site constraints however it is envisaged that grouting shall start from the deepest part of the seam (i.e. down dip) working up to the shallowest holes i.e. working from the west of the Site (subject to detailed phasing, to be agreed);
- Where necessary holes will be inclined to avoid existing services;
- Temporary casing will be installed to the depth of rockhead (varies between 15m and 17.7mbgl), preventing any impact on the overlying superficial deposits and Made Ground;
- Drilling will be progressed using water flush, standard good practice to be implemented to control surface run off;

The following plant is anticipated to be utilised during these works (subject to contractor's risk assessment and method statements):

- Mini piling rig;
- Grout mixer, silo and pump;
- Compressors;
- Telehandler;
- JCB;
- Fuel Bowser; and
- Ancillary Tools (Drilling).

4 Part A – Groundwater Risk Assessment and Mitigation

4.1 General

A full description of the groundwater testing and analysis undertaken is provided in the Buro Happold Generic Quantitative Risk Assessment (ETC-BHE-ZX-XX-RP-CG-0003) [3].

4.2 Receptors

The Secondary A Aquifer - The Secondary A Aquifer within the Coal Measures is not considered as a sensitive receptor at this location (see below) but it does have the potential to be a plausible migration pathway. The aquifer is not considered a sensitive receptor with respect to contamination as its quality has already been degraded due to the mining and industrial history, the nature of the Coal Measures aquifer itself and the absence of local abstractions. In addition, the previous grouting will have affected its capacity, although, records from those works indicate that this impact was relatively limited (grout take was limited in areas where data is available). No data has been made available for review regarding the grouting works for the Stadium construction in 2000. A grout grid plan has been provided and this shows a reduction in the grid spacing, indicated higher grout takes within the area (see Drawing ETC-BHE-ZX-XX-DR-CG-1003). On the basis of all of the above, the proposed grouting is to target future pile bases, though grout take volumes are not anticipated to be significant therefore it is unlikely to have any significant or measurable effect upon the quality or properties of the aquifer. The Secondary A Aquifer is considered a sensitive receptor with respect to the proposed grout works and therefore subject to assessment below.

River Medlock - The groundwater table within the Coal Measures was consistently between +38mOD and +41mOD, see Figure 1 above (distribution shown in drawing ETC-BHE-ZX-XX-DR-CG-1009). The river at its nearest point is located approximately 160m northwest within a brick-built culvert. The nearest point outside of the culvert is >300m west. Currently the river sits at approximately +35mOD to +36mOD (data obtained by the Environment Agency over the last 12 months presented on River Levels website [5]) though the highest recorded level has been +39mOD (level recorded in 2019). The flow direction is south-west. There is little evidence to confirm any hydraulic continuity exists between the culverted river and the groundwater in the Coal Measures aquifer. The groundwater flow direction was reported to be in a westerly direction [4], towards the River Medlock. However, the recent ground investigation data [see Drawing ETC-BHE-ZX-XX-DR-CG-1009] appears to indicate groundwater may flow towards the east / south-east. Nonetheless the water in the River Medlock is considered as a sensitive receptor with respect to the proposed grout works and therefore is subject to further assessment below.

The envisaged proposed grouting mix will be 10:1 PFA:Cement, this consistency will be sufficient for filling any fractures and shall solidify before it has the opportunity to travel very far.

Perched Water - Perched groundwater was recorded in several localised areas within the Made Ground (between 0.7m and 2.3m bgl) and is likely to be present due to low permeability bands in the Made Ground which inhibit downward percolation of rainwater. There is no evidence that the Secondary Aquifer within the Coal Measures and the perched water table are in continuation with one another or with off Site receptors. Perched water is not considered as a sensitive receptor with respect to the proposed grout works and therefore is not considered further within this assessment.

Ashton Canal - The Canal is located north of the Site (approximately 35m north), beyond the Metrolink cutting. The canal climbs for 10.8km through 18 locks toward Ashton-under-Lyne. Lock No.9 is located near to the Site (northeast) resulting in approximately 3.5m ground level change. To the east side of Lock No. 9 the level is at approximately

+60.4mOD and to the west of the lock (north of the Site) the ground drops to +56.7mOD. The level (from topographical surveys) suggests the water level in the canal nearest to the Site to be at about +55.7mOD. The Metrolink cutting is at about +53.8mOD, deeper than the canal by some 2m. The Canal will be lined and is likely to be situated within the Glacial Till deposits. The water in the Ashton Canal is not considered a sensitive receptor with respect to the proposed grout works and therefore is not considered further within this assessment.

Mine shafts - On occasion, the change in below ground circumstances can trigger a mine shaft or seams to collapse (induced stress to roof strata or pillars of lower seams). There are no known existing shafts on the Site. Shafts within the surrounding area have previously been grouted and either plugged or capped with the exception of one shaft (Shaft H) located approximately 25m east of the Site, see CMRA [2]. The proposed grout works do not anticipate large volumes of grout to be injected into the ground therefore displacement of significant volumes of groundwater is unlikely. Based on this information it is considered there is no plausible potential for the mine shafts to collapse due to groundwater displacement. Accordingly, mine shaft collapse has not been considered further within this assessment.

Occupiers of neighbouring land - Infill grouting can drive contaminated waters to the surface, or beneath neighbouring property, thereby creating a potential hazard. As described above, there are no local groundwater abstractions that could be adversely affected by the proposed grouting. The Secondary Aquifer is located within the Coal Measures which are overlain by some 11-12m of superficial Glacial Till deposits (low permeability clay). Localised perched water was encountered during the ground investigation within the Made Ground. During grouting activities all locations will be suitably cased off down to the rockhead (Coal Measures) preventing any connection with the overlying shallow perched water table. There is also no plausible potential for the contaminated waters within the Secondary A Aquifer to reach the surface nor is there any plausible connection between the grouting activities and the perched water table that can cause harm to occupiers of neighbouring land. On this basis occupiers of neighbouring land have not been considered further within this assessment.

4.3 Pollutant linkages

With respect to the proposed grout works and in accordance with the relevant CIRIA guidance, C758D [6] a groundwater risk assessment has been produced to determine the nature and extent of the risks from the proposed grouting upon the controlled waters (River Medlock and Ashton Canal), Secondary Aquifer and mine shafts.

Consideration has been given to dissipation rates of groundwater. The rate of filling below the groundwater table is dictated by the rate at which water is displaced and the type and nature of the fill dictates the potential for introduction of pollutants from the grouting operation. The permeability of the strata, extent of any voids and in the case of the shafts, the lining details, will dictate how and where grout, displaced water and mobilised fill will migrate. Groundwater monitoring and sampling, installation of a perimeter boundary and possible groundwater/mine water pumping may be required during grouting to ensure sufficient grout take and infill.

All potential pathways and receptors associated with the grout works have been considered below within the groundwater risk assessment (Table 3) in general accordance with C758D [6] and consistent with C552 risk evaluation tables [7].

Table 3 Groundwater Risk Assessment and Proposed Mitigation

Source	Potential Pathway	Sensitive Receptor	Consequence	Probability	Risk	Hazard realisation and mitigation	Completion / actions
Grout works within previously mined areas	Infill grout contaminating waters within the Secondary Aquifer (Coal Measures)	Secondary Aquifer	Medium	Unlikely	Low	No significant grout takes were encountered during the previous grout treatment works to the north of the Site (associated with the Metrolink). No voids encountered at the Site during the recent site investigation although zones of fracturing recorded. Mitigation Daily groundwater monitoring to take place during the works (see Appendix A). Further specific groundwater level monitoring should be carried where any significant grout takes are encountered, methodology to be approved by EA (see Appendix A and drawing ETC-BHE-ZX-XX-DR-CG-1009). Contingency / management plan in the event monitoring records displace groundwater and/ or substantial grout takes (to be outlined within the Contractor's Risk Assessment)	Where increased grout takes recorded, EA to be informed and method to proceed agreed. All records should be compiled and included within the Contractors completion report.
Grout works within previously mined areas	Infill grout below the water table driving contaminated waters to surface via permeable horizons (Coal Measures)	River Medlock	Medium	Unlikely	Low	No significant grout takes were encountered during the previous grout treatment works to the north of the Site (associated with the Metrolink). No voids encountered at the Site during the recent site investigation although zones of fracturing recorded. River > 160m distant, culverted with water level typically approx. 3m above groundwater level Mitigation Continuous inspection of River Medlock upstream and downstream of the Site to take place during works (see Appendix A). Further specific groundwater level monitoring should be carried where any significant grout takes are encountered, methodology to be approved by EA (see Appendix A and drawing ETC-BHE-ZX-XX-DR-CG-1009). Contingency / management plan in the event monitoring records displace groundwater and / or substantial grout takes (to be outlined within the Contractor's Risk Assessment) .	Where increased grout takes recorded, EA to be informed and method to proceed agreed. All records should be compiled and included within the Contractors completion report.

5 Part B – Response to Regulatory Position Statement (108)

The EA require a response to the following criteria as set out in the RPS 108 – Grouting Media under ‘Our Approach’:

1. The location does not fall within a groundwater Source Protection Zone 1.
 - a. No, the Site does not fall within a groundwater Source Protection Zone 1.
2. The injection is solely below the ground surface.
 - a. Yes, the injection of grout will be below rock head level (over +44mOD) and down to approximately 30mbgl (envisaged pile base depths and zone of influence to be confirmed).
3. The activity complies with the requirements of any necessary planning approvals.
 - a. Yes.
4. You have carried out an assessment of the ground conditions and potential receptors and are able to confirm the pollution will not occur from your operation.
 - a. Yes, a full assessment of the ground conditions is presented within the Buro Happold Generic Quantitative Risk Assessment Report [3] which confirms there are limited pollution pathways to sensitive receptors (i.e. River Medlock). This has been further clarified by the risk assessment presented in Section 4 of this Report.
5. The operation does not involve the discharge of hazardous substances or non-hazardous pollutants other than those inherently part of the solid content of the grout or other media essential additives.
 - a. No. Details of the solid content of the grout media to be confirmed in due course (upon appointment of the specialist grouting contractor), currently anticipated to be 10:1 PFA:Cement.
6. The materials forming the grout or other media comply with all relevant waste protocols, such as the quality on use of PFA, and any other relevant code of practice.
 - a. Correct. This will be confirmed in due course by the method statements of the specialist grouting contractor.
7. There will be no liquid discharge other than slurry formed by grout or other media in admixture with water.
 - a. Correct. This will be confirmed in due course by the method statements of the specialist grouting contractor.
8. The activity does not constitute or form part of another regulated facility such as an installation, waste or mining waste operation as listed in EPR 2010 Regulation 8.
 - a. No.

6 Appropriate Assessment Record (as set out in RPS108 Appendix 1)

Table 4 Relevant Contact Details

Name	Address	Contact
Buro Happold Ltd (Company)	230 Lower Bristol Rd Bath BA2 3DQ	0122 532 0600 Francesca.Gould@burohappold.com Hugh.Mallet@burohappold.com Chris.O'Hara@burohappold.com
Laing O'Rourke (Company)	Citygate 2, Crossgate Sale, Manchester M33 7JR	07385979175 NathanDoyle@laingorourke.com
Gardiner and Theobald LLP (Company)	Merchant Exchange 17-19 Whitworth Street West Manchester M1 5WG	07795617902 J.Walsh@Gardiner.com

Address and National Grid Reference:

The proposed grout works will take place on the Site located at National Grid Reference SJ 86780 98622, part of the Etihad Campus, Manchester M11 3HY.

Nature of activity or discharge:

The proposed work includes injection of grout at the pile bases beneath the Site located within the Coal Measure strata.

Read and understood full text of the Position Statement (RPS 108):

The full text of the Regulatory Position Statement 108 has been read and understood by Buro Happold Ltd on behalf of the above listed names (see Table 4) to ensure compliance when carrying out the proposed grout works.

Specify codes of practice, waste protocols or other standards relevant to the discharges of our activities into groundwater:

The proposed work will comply with British Standards (namely, BS EN 1008:2002, BS EN 197-1:2000, BS EN 12620:2002) and the regulatory position statement [8] relevant to the discharges of grout into groundwater. To confirm compliance of such activities, all works will be documented (see Appendix A for proposed groundwater level monitoring) and evidence compiled within the Contractors completion report.

Compliance with the requirements in those specified standards:

A full assessment of the ground conditions is presented within the Buro Happold Generic Quantitative Risk Assessment (ETC-BHE-ZX-XX-CG-RP-0003) [3]. The assessment was carried out in general accordance with the CIRIA Contaminated Land Risk Assessment (C552) [7], the Environment Agency (EA) Land Contamination Risk Management [9], the relevant British Standards (BS) [10] and [11], the EA Guiding Principles for Land Contamination [12], Groundwater Protection Policy [13] and other good practice guidance.

Methodology of assessment to the ground conditions and relevant receptors:

An initial conceptual site model assessing the potential pollutant linkages (source-pathway-receptor) was developed within the Desk Study Report (ETC-BHE-ZX-XX-CG-RP-0001 P04) [14] in general accordance with C552 [7]. This desk-based research informed the design of the site investigation, carried out late 2022 continuing into 2023. A detailed land contamination risk assessment was completed following the site investigation with the findings presented within the Buro Happold Generic Quantitative Risk Assessment (ETC-BHE-ZX-XX-CG-RP-0003) [3].

Outcome of the assessment and reasons why risks of causing pollution to groundwater is low:

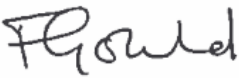
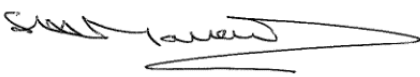
The relevant pollutant linkages associated with the injection of grout below the groundwater table have been reassessed in general accordance with relevant CIRIA guidance ([6] and [7]) within Part A of this Groundwater Risk Assessment. The assessment is presented within Table 3. All potential pollutant linkages were assessed as low due to the following:

- the nature and extent of the proposed grout work activity;
- the potential for the pollutant to travel off Site and impact sensitive receptors; and
- the mitigation measures in place to ensure any alterations to groundwater level is identified and works stopped where such changes occur (see Appendix A – Groundwater level monitoring proposals).

Confirmation full compliance with the requirements set out in the Position Statement (RPS 108):

All works detailed within this groundwater risk assessment have been carried out in conjunction with the Regulatory Position Statement 108 as advised by the Environment Agency within their letter dated 20th December 2022 and earlier email dated 10th November 2022.

RPS 108 compliance, signed and dated:

Author: Francesca Gould (Senior Geoenv. Engineer)		24 th February 2023
Reviewed: Hugh Mallett (Technical Director)		24 th February 2023

7 Conclusions and Recommendations

7.1 Risks and mitigation

The risks associated with the proposed grout works have been assessed in general accordance with relevant guidance, namely the Environment Agency RPS 108 [8] and CIRIA C552 [7] and CIRIA C758D [6] .

It is not anticipated that the proposed grouting will adversely impact upon the Coal Measures Secondary A aquifer. This conclusion reflects the evidence from the previous grouting works, the anticipated nature of the strata, the nature and quality of the aquifer / groundwater and the absence of local abstraction.

The potential risks to the River Medlock associated with the proposed grouting works are assessed as Low. This conclusion primarily reflects the expected nature / extent of the grouting works (i.e. limited grout take), the likely limited effect on groundwater levels both on and off Site, and the distance between the Site and the river.

The potential risks to the Ashton Canal associated with the potential for contaminated run-off from the proposed grouting works are also assessed as Very Low. This conclusion reflects the indirect migration pathway between the Site and the canal: a deeper cutting associated with the Metrolink is present and both the canal and cutting are likely founded within the low permeable Glacial Till deposits. During the works hazardous materials can readily be located away from sensitive locations and standard good practice measures to prevent uncontrolled run off can readily be adopted. These residual risks are capable of mitigation (see below).

All risks are assessed as Very Low to Low providing implementation of standard good practice (groundwater control measures) as set out in the contractor's method statements, and suitable groundwater monitoring (see Appendix A) are carried out prior to, during and post grout treatment. All records will be compiled and included within the Contractors Completion Report.

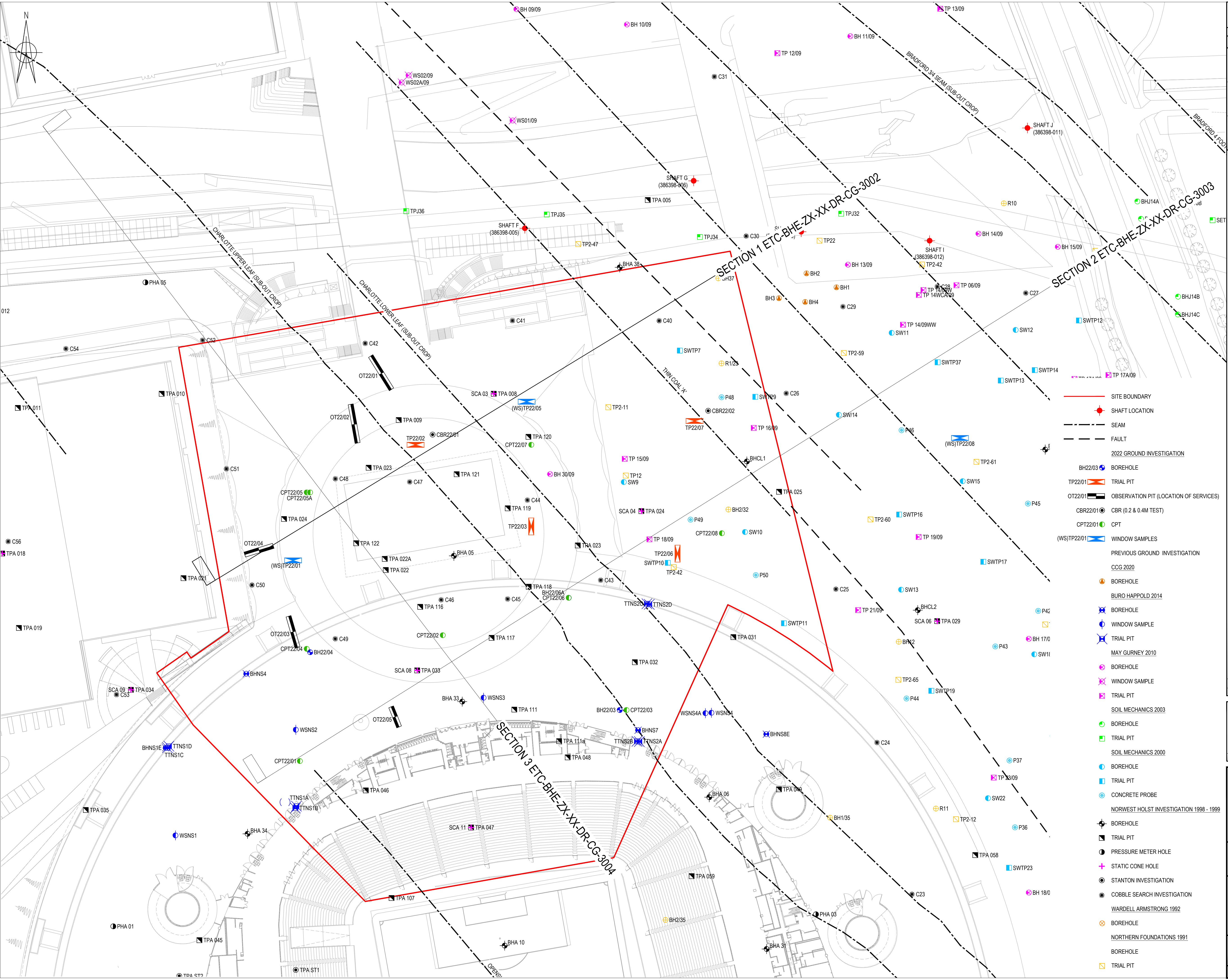
7.2 Environmental Permit

In accordance with the Environmental Permitting (England and Wales) Regulations, the Contractor may be required to obtain an environmental permit for grouting works below the groundwater table. Appropriate liaison with the relevant regulator (Environment Agency) – which should include submission of this Groundwater Risk Assessment may remove the requirement of such a permit.

It is concluded that the assessment presented above, including the proposed monitoring of groundwater levels and an appropriate contingency plan agreed following appointment of the specialist grout Contractor will ensure that the proposed grout works (which include injection below the water table), will not have a detrimental impact on controlled waters (the groundwater regime in the Coal Measures) and the nearby surface waters (River Medlock, Ashton Canal). Accordingly, the Environment Agency are invited to agree with the assessment and the conclusions reached and thus determine that the proposed grouting works on the Site do not require an Environmental Permit.

Drawings

Drawing Reference	Drawing Title
ETC-BHE-ZX-XX-DR-CG-3001-4	Cross Sections
ETC-BHE-ZX-XX-DR-CG-2002	Mining Constraints Plan
ETC-BHE-ZX-XX-DR-CG-1009	Groundwater level monitoring locations and levels
ETC-BHE-ZX-XX-DR-CG-1003	Existing Grout Layout
ETC-BHE-ZX-XX-DR-CG-1007	Proposed Grouting Layout



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MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

Notes

— SITE BOUNDARY
● SHAFT LOCATION
--- SEAM
--- FAULT
2022 GROUND INVESTIGATION
BH22/03 BOREHOLE
TP22/01 TRIAL PIT
OT22/01 OBSERVATION PIT (LOCATION OF SERVICES)
CBR22/01 CBR (0.2 & 0.4M TEST)
CPT22/01 CPT
(WS)TP22/01 WINDOW SAMPLES
PREVIOUS GROUND INVESTIGATION
CGG 2020
● BOREHOLE
BURO HAPPOLD 2014
✕ BOREHOLE
● WINDOW SAMPLE
✕ TRIAL PIT
MAY GURNEY 2010
● BOREHOLE
✕ WINDOW SAMPLE
✕ TRIAL PIT
SOIL MECHANICS 2003
● BOREHOLE
✕ TRIAL PIT
SOIL MECHANICS 2000
● BOREHOLE
✕ TRIAL PIT
● CONCRETE PROBE
NORWEST HOLST INVESTIGATION 1998 - 1999
● BOREHOLE
✕ TRIAL PIT
● PRESSURE METER HOLE
+ STATIC CONE HOLE
● STANTON INVESTIGATION
* COBBLE SEARCH INVESTIGATION
WARDLE ARMSTRONG 1992
✕ BOREHOLE
NORTHERN FOUNDATIONS 1991
● BOREHOLE
✕ TRIAL PIT

POT INFORMATION		24.02.23	NG	FG
Rev	Description	Date	Dm	Cr'd

INFORMATION

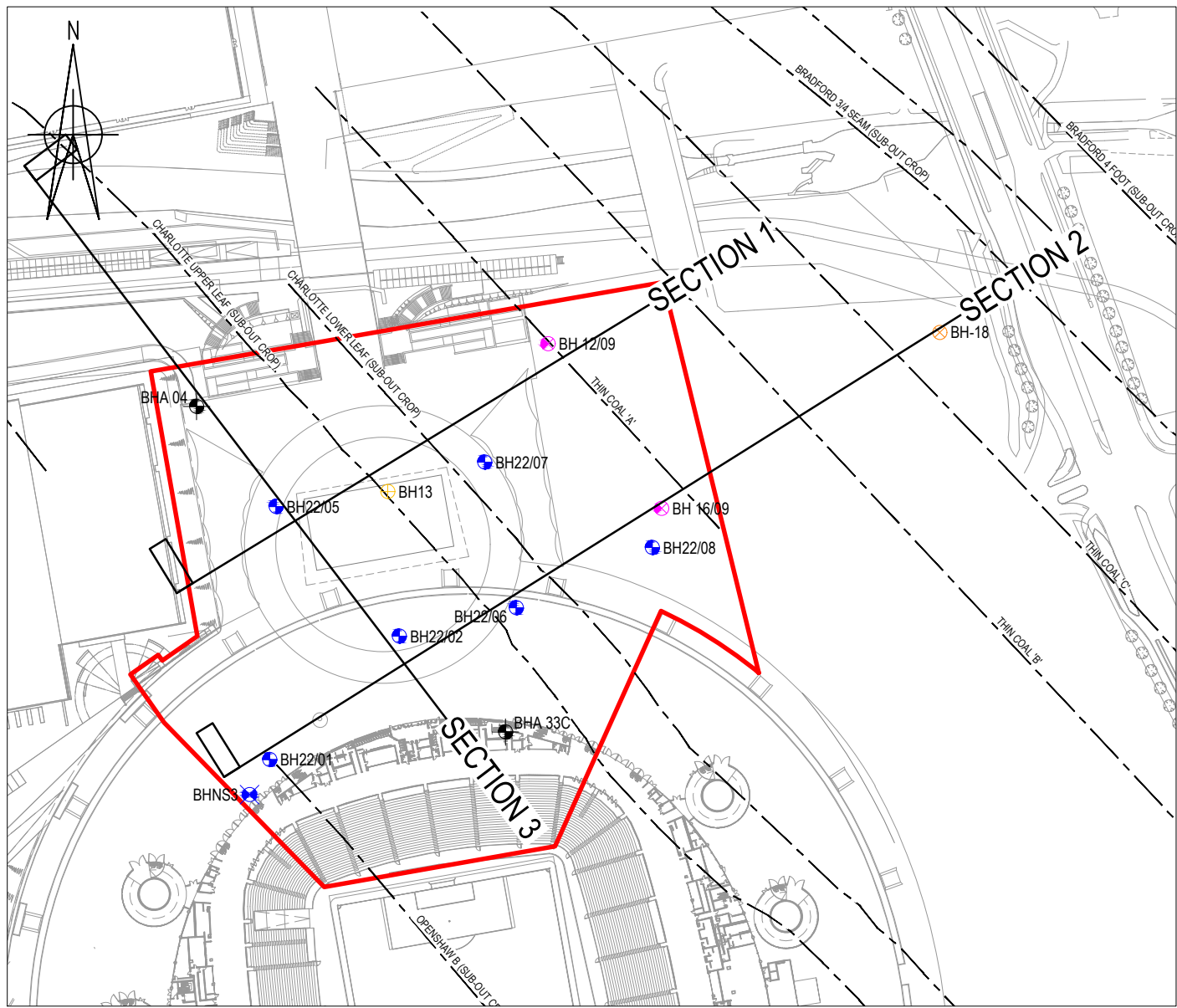
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Architect	
Project	ETIHAD CAMPUS SITE IMPROVEMENT WORKS
Org Title	CROSS SECTION LOCATION PLAN

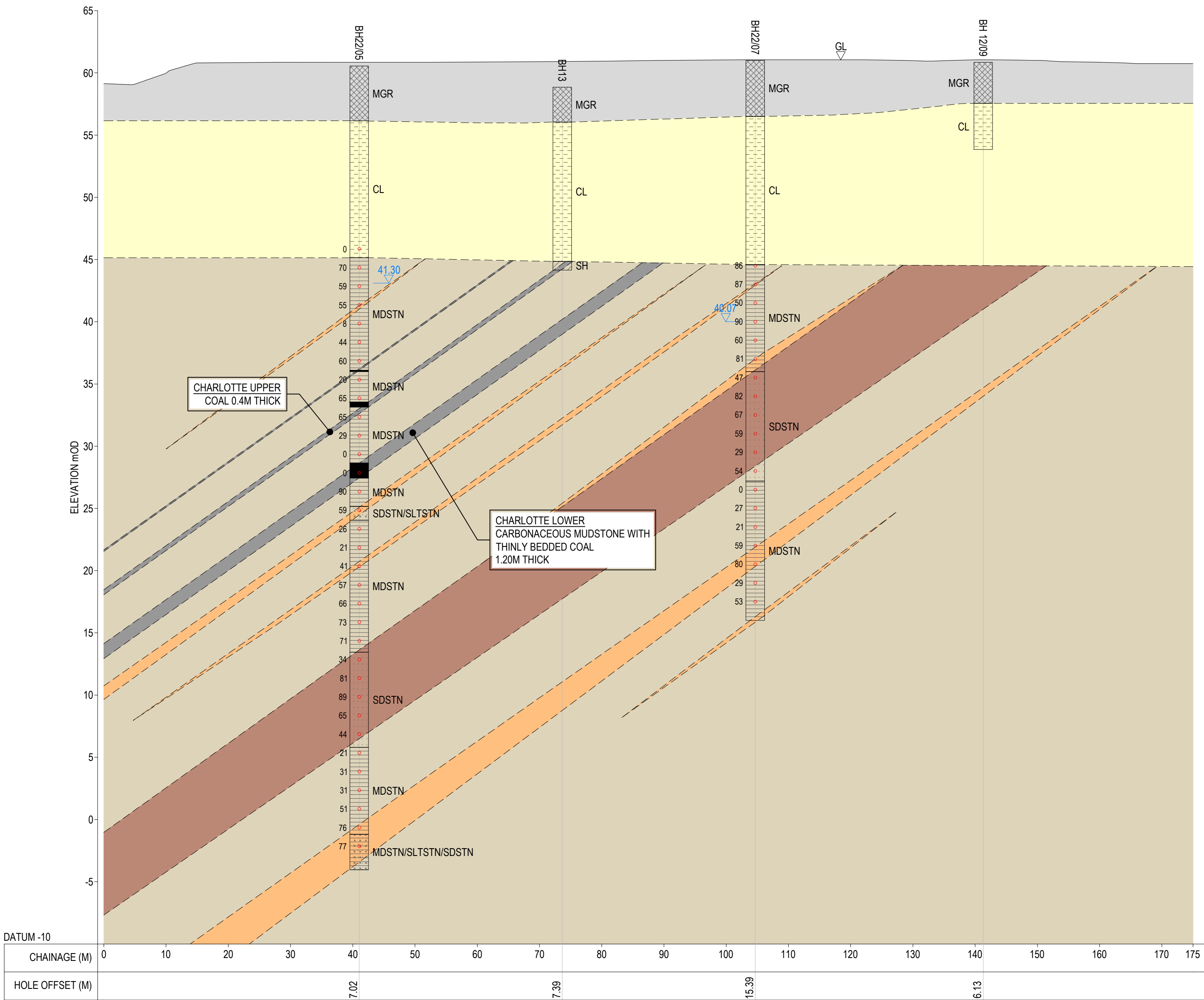
Scales@A1 1:500	Job No. 0053810
Drawn by NG	Date FEB 2023
Checked by FG	Rev P01

Drawing No. ETC-BHE-ZX-XX-DR-CG-3001



- BOREHOLE - BURO HAPPOLD 2022
- BOREHOLE - BURO HAPPOLD 2014
- BOREHOLE - MAY GURNEY 2010
- BOREHOLE - NORWEST HOLST 1998
- BOREHOLE - WARDELL ARMSTRONG 1992
- BOREHOLE - NORTHERN FOUNDATIONS 1991

SECTION 1
SCALES: HORIZ - 1:500 VERT - 1:250



- SITE BOUNDARY
- INDICATIVE SEAM
- POSSIBLE FAULT LOCATION
- GROUND LEVEL FROM TOPOGRAPHICAL SURVEY DATA
- AVERAGE GROUNDWATER LEVEL (mOD)
- MADE GROUND
- CLAY
- SAND
- SHALE
- SILTSTONE
- SANDSTONE
- MUDSTONE
- ASSESSED ZONE OF CORE LOSS
- INFERRED GEOLOGY
- MADE GROUND
- GLACIAL TILL
- COAL MEASURES
- COAL SEAMS
- SANDSTONE
- SILTSTONE & SANDSTONE
- MUDSTONE/SILTSTONE/SANDSTONE

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Notes

POT INFORMATION	24.02.23	NG	FG
Rev	Description	Date	Dm

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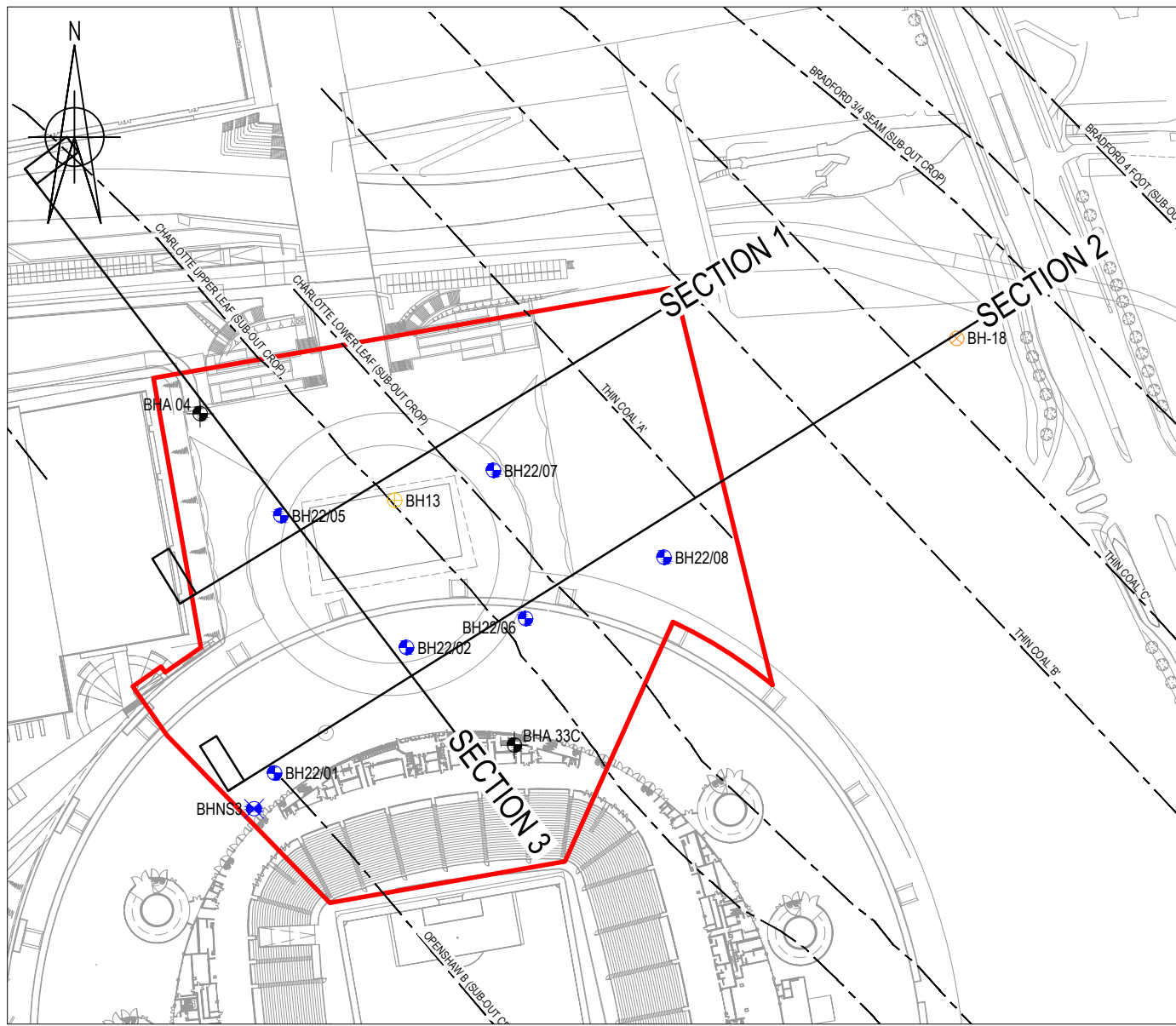
Architect
Project
Drg Title

ETIHAD CAMPUS SITE IMPROVEMENT WORKS
GEOLOGICAL CROSS SECTIONS
SHEET1

Scales@A1 1:1250
Drawn by NG
Checked by FG

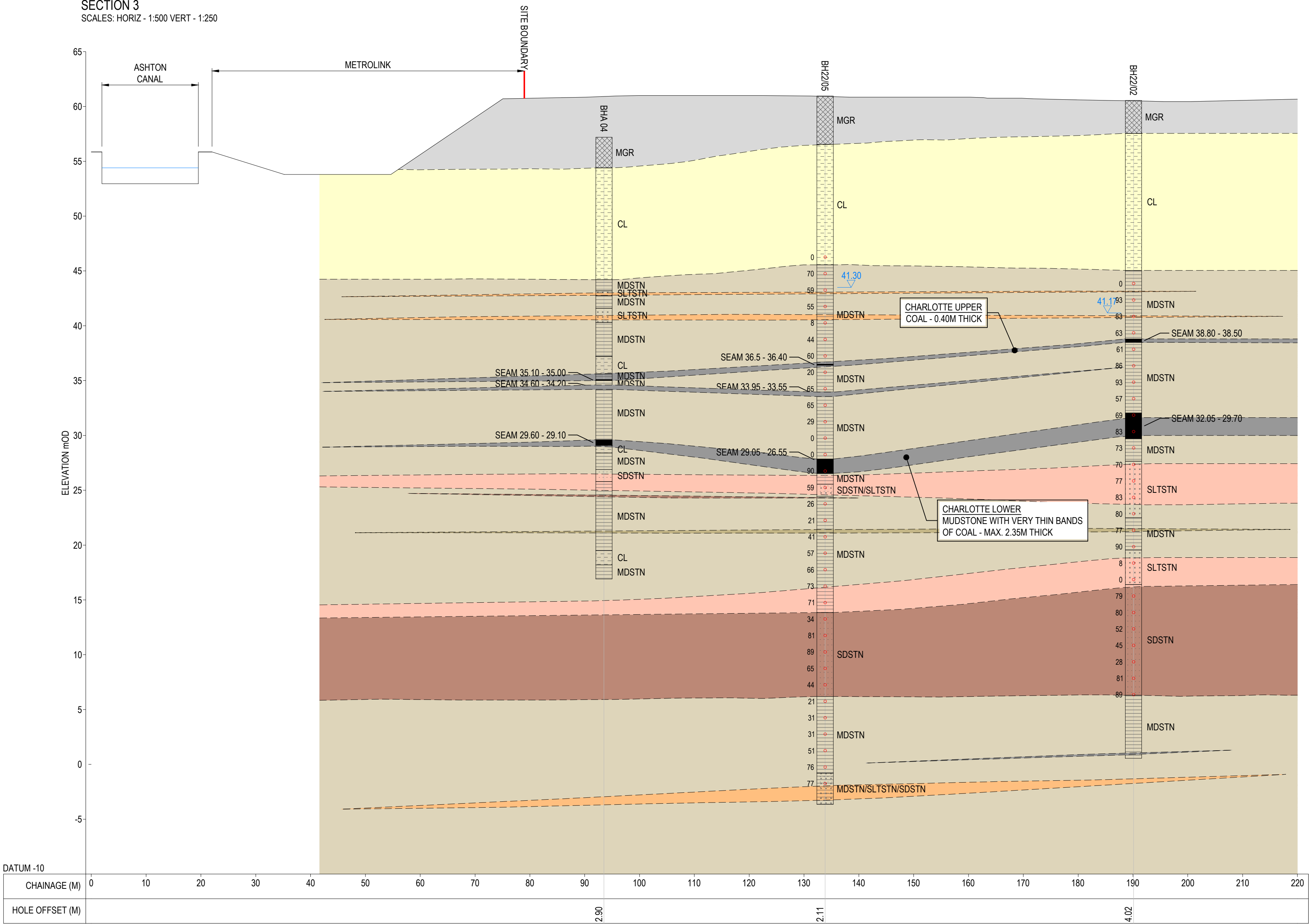
Job No. 0053810
Date FEB 2023
Rev P01

Drawing No. ETC-BHE-ZX-XX-DR-CG-3002



- BOREHOLE - BURO HAPPOLD 2022
- BOREHOLE - BURO HAPPOLD 2014
- BOREHOLE - MAY GURNEY 2010
- BOREHOLE - NORWEST HOLST 1998
- BOREHOLE - WARDELL ARMSTRONG 1992

SECTION 3
SCALES: HORIZ - 1:500 VERT - 1:250



- SITE BOUNDARY
- INDICATIVE SEAM
- POSSIBLE FAULT LOCATION
- GROUND LEVEL FROM TOPOGRAPHICAL SURVEY DATA
- AVERAGE GROUNDWATER LEVEL (mOD)
- MADE GROUND
- CLAY
- SAND
- SHALE
- SILTSTONE
- SANDSTONE
- MUDSTONE
- ASSESSED ZONE OF CORE LOSS
- INFERRED GEOLOGY
- MADE GROUND
- GLACIAL TILL
- COAL MEASURES
- COAL SEAMS
- SANDSTONE
- SILTSTONE & SANDSTONE
- MUDSTONE/SILTSTONE/SANDSTONE

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DECOMMISSIONING/DEMOLITION.

Notes

POT INFORMATION 24.02.23 NG FG

Rev	Description	Date	Dm	Cr'd
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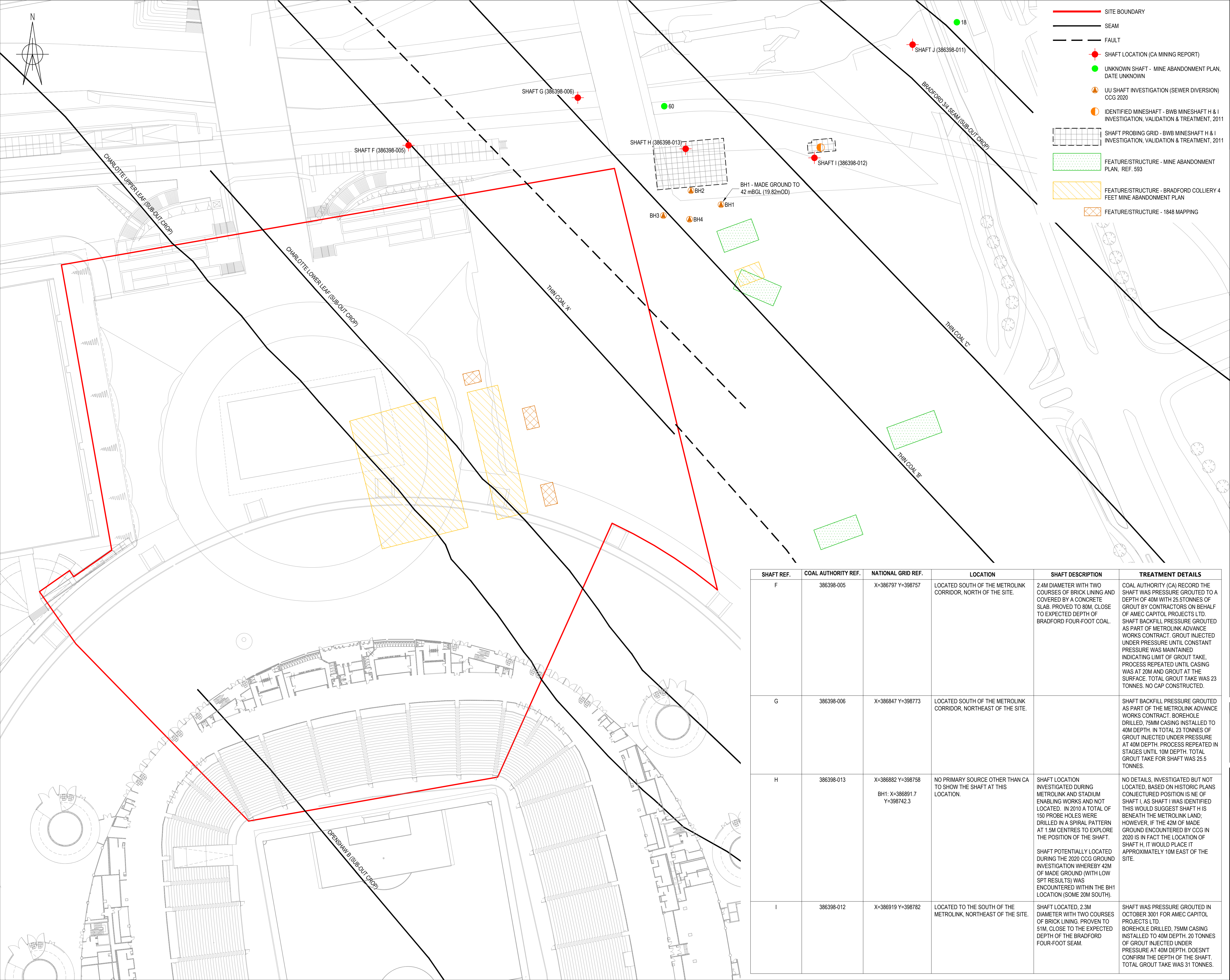
Architect

Project **ETIHAD CAMPUS SITE IMPROVEMENT WORKS**

Drg Title **GEOLOGICAL CROSS SECTIONS SHEET 3**

Scales@A1 1:1250	Job No. 0053810
Drawn by NG	Date FEB 2023
Checked by FG	Rev P01

Drawing No. **ETC-BHE-ZX-XX-DR-CG-3004**



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Notes

1. WHERE SHAFT COORDINATES ARE NOT AVAILABLE, PLANS HAVE BEEN OVERLAID AS ACCURATELY AS POSSIBLE. REFERENCE SHOULD BE MADE TO ORIGINAL PLANS AND EXACT LOCATIONS ON THIS PLAN CAN NOT BE RELIED UPON.

SHAFT REF.	COAL AUTHORITY REF.	NATIONAL GRID REF.	LOCATION	SHAFT DESCRIPTION	TREATMENT DETAILS
F	386398-005	X=386797 Y=398757	LOCATED SOUTH OF THE METROLINK CORRIDOR, NORTH OF THE SITE.	2.4M DIAMETER WITH TWO COURSES OF BRICK LINING AND COVERED BY A CONCRETE SLAB. PROVED TO 80M, CLOSE TO EXPECTED DEPTH OF BRADFORD FOUR-FOOT COAL.	COAL AUTHORITY (CA) RECORD THE SHAFT WAS PRESSURE GROUTED TO A DEPTH OF 40M WITH 25.5TONNES OF GROUT BY CONTRACTORS ON BEHALF OF AMEC CAPITOL PROJECTS LTD. SHAFT BACKFILL PRESSURE GROUTED AS PART OF METROLINK ADVANCE WORKS CONTRACT. GROUT INJECTED UNDER PRESSURE UNTIL CONSTANT PRESSURE WAS MAINTAINED INDICATING LIMIT OF GROUT TAKE. PROCESS REPEATED UNTIL CASING WAS AT 20M AND GROUT AT THE SURFACE. TOTAL GROUT TAKE WAS 23 TONNES. NO CAP CONSTRUCTED.
G	386398-006	X=386847 Y=398773	LOCATED SOUTH OF THE METROLINK CORRIDOR, NORTHEAST OF THE SITE.		SHAFT BACKFILL PRESSURE GROUTED AS PART OF THE METROLINK ADVANCE WORKS CONTRACT. BOREHOLE DRILLED. 75MM CASING INSTALLED TO 40M DEPTH. IN TOTAL 23 TONNES OF GROUT INJECTED UNDER PRESSURE AT 40M DEPTH. PROCESS REPEATED IN STAGES UNTIL 10M DEPTH. TOTAL GROUT TAKE FOR SHAFT WAS 25.5 TONNES.
H	386398-013	X=386882 Y=398758 BH1: X=386891.7 Y=398742.3	NO PRIMARY SOURCE OTHER THAN CA TO SHOW THE SHAFT AT THIS LOCATION.	SHAFT LOCATION INVESTIGATED DURING METROLINK AND STADIUM ENABLING WORKS AND NOT LOCATED. IN 2010 A TOTAL OF 150 PROBE HOLES WERE DRILLED IN A SPIRAL PATTERN AT 1.5M CENTRES TO EXPLORE THE POSITION OF THE SHAFT. SHAFT POTENTIALLY LOCATED DURING THE 2020 CCG GROUND INVESTIGATION WHEREBY 42M OF MADE GROUND (WITH LOW SPT RESULTS) WAS ENCOUNTERED WITHIN THE BH1 LOCATION (SOME 20M SOUTH).	NO DETAILS, INVESTIGATED BUT NOT LOCATED, BASED ON HISTORIC PLANS CONJECTURED POSITION IS NE OF SHAFT I, AS SHAFT I WAS IDENTIFIED THIS WOULD SUGGEST SHAFT H IS BENEATH THE METROLINK LAND; HOWEVER, IF THE 42M OF MADE GROUND ENCOUNTERED BY CCG IN 2020 IS IN FACT THE LOCATION OF SHAFT H, IT WOULD PLACE IT APPROXIMATELY 10M EAST OF THE SITE.
I	386398-012	X=386919 Y=398782	LOCATED TO THE SOUTH OF THE METROLINK, NORTHEAST OF THE SITE.	SHAFT LOCATED, 2.3M DIAMETER WITH TWO COURSES OF BRICK LINING. PROVEN TO 51M, CLOSE TO THE EXPECTED DEPTH OF THE BRADFORD FOUR-FOOT SEAM.	SHAFT WAS PRESSURE GROUTED IN OCTOBER 2001 FOR AMEC CAPITOL PROJECTS LTD. BOREHOLE DRILLED. 75MM CASING INSTALLED TO 40M DEPTH. 20 TONNES OF GROUT INJECTED UNDER PRESSURE AT 40M DEPTH. DOESNT CONFIRM THE DEPTH OF THE SHAFT. TOTAL GROUT TAKE WAS 31 TONNES.

P03 BOUNDARY UPDATE. ISSUED FOR INFORMATION.	24.02.23	NG	FG
P02 BOUNDARY UPDATE. ISSUED FOR INFORMATION.	03.02.23	NG	FG
P01 INFORMATION	09.12.22	NG	FG
Rev Description	Date	Dm	Ch'd

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Architect

Project **ETIHAD CAMPUS SITE IMPROVEMENT WORKS**

Drg Title **MINING CONSTRAINTS PLAN**

Scales@A1 1:5000

Drawn by NG

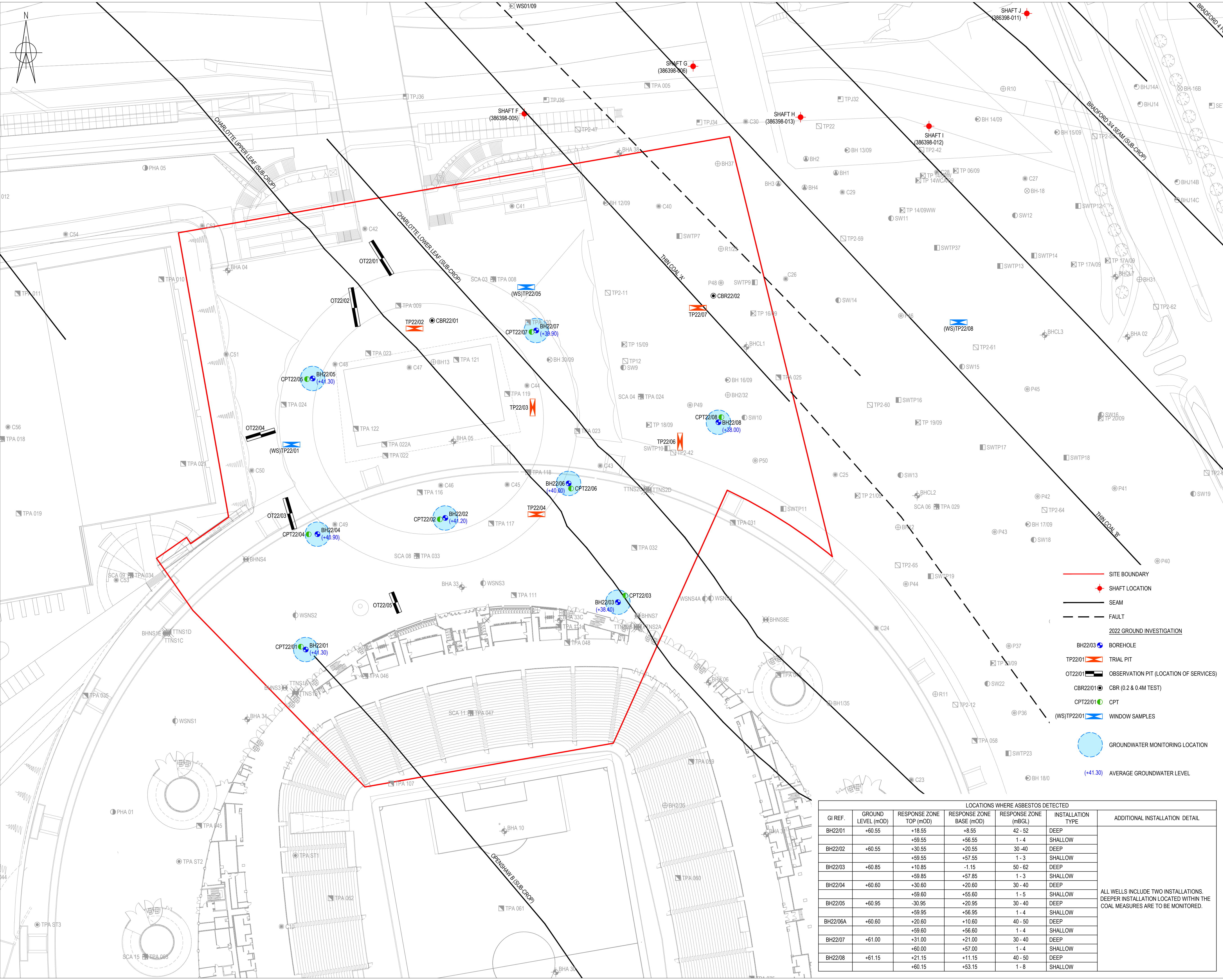
Checked by FG

Job No. **0053810**

Date **DEC 2022**

Rev **P03**

Drawing No. **ETC-BHE-ZX-XX-DR-CG-2002**



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Notes

P01 INFORMATION 24.02.23 NG CO

Rev	Description	Date	Dwn	Ch'd
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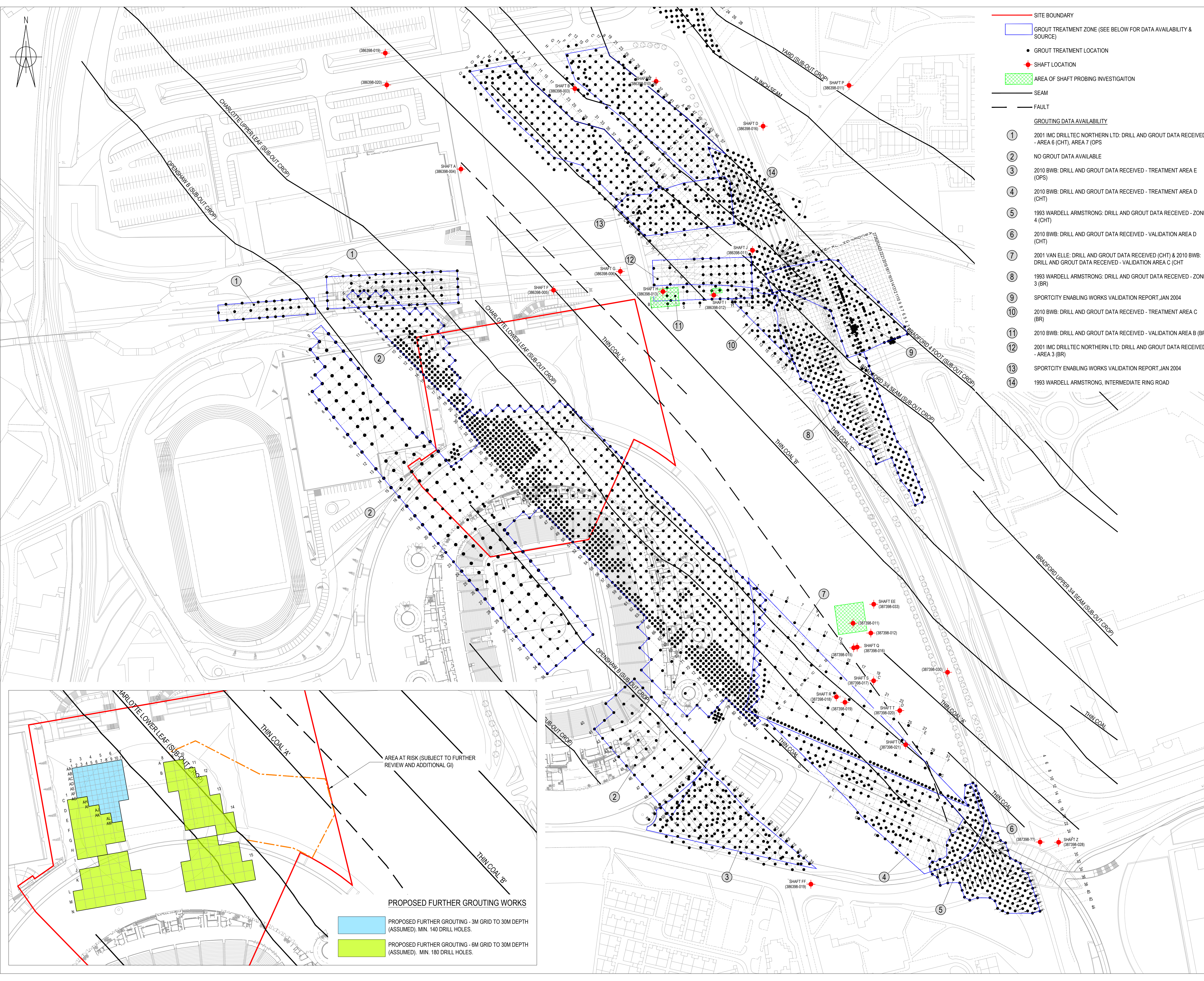
Project **ETIHAD CAMPUS SITE IMPROVEMENT WORKS**

Dwg Title **GROUNDWATER MONITORING**

Scales@A1 1:500	Job No. 0053810
Drawn by NG	Date FEB 2022
Checked by CO	Rev P01

Drawing No. **ETC-BHE-ZX-XX-DR-CG-1009**

LOCATIONS WHERE ASBESTOS DETECTED						
GI REF.	GROUND LEVEL (mOD)	RESPONSE ZONE TOP (mOD)	RESPONSE ZONE BASE (mOD)	RESPONSE ZONE (mBGL)	INSTALLATION TYPE	ADDITIONAL INSTALLATION DETAIL
BH22/01	+60.55	+18.55	+8.55	42 - 52	DEEP	ALL WELLS INCLUDE TWO INSTALLATIONS. DEEPER INSTALLATION LOCATED WITHIN THE COAL MEASURES ARE TO BE MONITORED.
BH22/02	+60.55	+30.55	+20.55	30 - 40	DEEP	
BH22/03	+60.85	+10.85	-1.15	50 - 62	DEEP	
BH22/04	+60.60	+30.60	+20.60	30 - 40	DEEP	
BH22/05	+60.95	+30.95	+20.95	30 - 40	DEEP	
BH22/06A	+60.60	+20.60	+10.60	40 - 50	DEEP	
BH22/07	+61.00	+31.00	+21.00	30 - 40	DEEP	
BH22/08	+61.15	+21.15	+11.15	40 - 50	DEEP	
		+60.00	+57.00	1 - 4	SHALLOW	
		+60.15	+53.15	1 - 8	SHALLOW	
		+59.55	+57.55	1 - 3	SHALLOW	
		+59.85	+57.85	1 - 3	SHALLOW	
		+59.60	+55.60	1 - 5	SHALLOW	
		+59.95	+56.95	1 - 4	SHALLOW	
		+59.60	+56.60	1 - 4	SHALLOW	
		+59.60	+56.60	1 - 4	SHALLOW	



- LEGEND**
- SITE BOUNDARY
 - GROUT TREATMENT ZONE (SEE BELOW FOR DATA AVAILABILITY & SOURCE)
 - GROUT TREATMENT LOCATION
 - SHAFT LOCATION
 - AREA OF SHAFT PROBING INVESTIGATION
 - SEAM
 - FAULT
- GROUTING DATA AVAILABILITY**
- | NO | DESCRIPTION |
|----|--|
| 1 | 2001 IMC DRILLTEC NORTHERN LTD: DRILL AND GROUT DATA RECEIVED - AREA 6 (CHT), AREA 7 (OPS) |
| 2 | NO GROUT DATA AVAILABLE |
| 3 | 2010 BWB: DRILL AND GROUT DATA RECEIVED - TREATMENT AREA E (OPS) |
| 4 | 2010 BWB: DRILL AND GROUT DATA RECEIVED - TREATMENT AREA D (CHT) |
| 5 | 1993 WARDELL ARMSTRONG: DRILL AND GROUT DATA RECEIVED - ZONE 4 (CHT) |
| 6 | 2010 BWB: DRILL AND GROUT DATA RECEIVED - VALIDATION AREA D (CHT) |
| 7 | 2001 VAN ELLE: DRILL AND GROUT DATA RECEIVED (CHT) & 2010 BWB: DRILL AND GROUT DATA RECEIVED - VALIDATION AREA C (CHT) |
| 8 | 1993 WARDELL ARMSTRONG: DRILL AND GROUT DATA RECEIVED - ZONE 3 (BR) |
| 9 | SPORTCITY ENABLING WORKS VALIDATION REPORT, JAN 2004 |
| 10 | 2010 BWB: DRILL AND GROUT DATA RECEIVED - TREATMENT AREA C (BR) |
| 11 | 2010 BWB: DRILL AND GROUT DATA RECEIVED - VALIDATION AREA B (BR) |
| 12 | 2001 IMC DRILLTEC NORTHERN LTD: DRILL AND GROUT DATA RECEIVED - AREA 3 (BR) |
| 13 | SPORTCITY ENABLING WORKS VALIDATION REPORT, JAN 2004 |
| 14 | 1993 WARDELL ARMSTRONG, INTERMEDIATE RING ROAD |

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Notes
REF: ARUP, COALSEAMS AND SHAFT LOCATIONS, DRAWING NO. ARP-LAY-CG-130, REVISION C, 01.03.2010.
BWB CONSULTING, SCOPE OF WORKS FOR MINE WORKINGS TREATMENT AND VALIDATION, DRAWING NO. NTH/185/211, REVISION P2, 14.10.2010.
BWB CONSULTING, FIGURE 5 VALIDATION AREA B MINE STABILISATION WORKS, DRAWING NO. NTH 185/03/AREA A/F5, 02.2011.
BWB CONSULTING, FIGURE 6 VALIDATION AREA C MINE STABILISATION WORKS, DRAWING NO. NTH 185/03/AREA B/F6, 02.2011.
BWB CONSULTING, FIGURE 7 VALIDATION AREA C MINE STABILISATION WORKS, DRAWING NO. NTH 185/03/AREA A/F7, 02.2011.
BWB CONSULTING, SCOPE OF WORKS FOR MINE WORKINGS TREATMENT AND VALIDATION SHEET 1, DRAWING NO. NTH/185/210, REVISION P2, 14.10.2010.
UTILITIES & EASEMENTS ARE NOT SHOWN ON THIS DRAWING. FOR SERVICES LOCATIONS SEE BURO HAPPOLD DRAWING NO. MNS-BHE-XX-XX-DR-CV-9101, COMBINED UTILITIES, REVISION P01, 08.09.22.

P03 BOUNDARY & PROPOSED GROUTING LAYOUT UPDATED. ISSUED FOR INFORMATION.	24.02.23	NG	FG	
P02 BOUNDARY UPDATE. ISSUED FOR INFORMATION.	03.02.23	NG	FG	
P01 INFORMATION	09.12.22	NG	FG	
Rev	Description	Date	Dm	Ch'd

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Architect	
Project ETIHAD CAMPUS SITE IMPROVEMENT WORKS	
Drg Title MINING TREATMENT AREAS	
Scales@A1 1:1250 Drawn by NG Checked by FG	Job No. 0053810 Date DEC 2022 Rev P03
Drawing No. ETC-BHE-ZX-XX-DR-CG-1003	



- SITE BOUNDARY
- SEAM
- PROPOSED FURTHER GROUTING WORKS
- INDICATIVE PROPOSED FURTHER GROUTING
3M GRID TO 30M DEPTH (ASSUMED).
- INDICATIVE PROPOSED FURTHER GROUTING
6M GRID TO 30M DEPTH (ASSUMED).
- INDICATIVE GROUTING LOCATION

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Notes

REF: ARUP, COALSEAMS AND SHAFT LOCATIONS, DRAWING NO. ARP-LAY-CG-130, REVISION C, 01.03.2010.

UTILITIES & EASEMENTS ARE NOT SHOWN ON THIS DRAWING. FOR SERVICES LOCATIONS SEE BURO HAPPOLD DRAWING NO. MNS-BHE-XX-XX-DR-CV-0101, COMBINED UTILITIES, REVISION P01, 08.09.22.

INDICATIVE GROUTING ZONES BASED ON THE PROPOSED LAYOUTS AS INDICATED ON THE POPULOUS DRAWING NSE-POP-ZZ-ZZ-DR-A-009100.

P02 BOUNDARY UPDATE. ISSUED FOR INFORMATION.

P01 INFORMATION.

Rev Description Date Dm Ctd

24.02.23 NG FG

10.02.23 NG FG

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Architect

Project

Drg Title

ETIHAD CAMPUS SITE IMPROVEMENT WORKS
INDICATIVE PROPOSED
GROUTING AREAS

Scales@A1 1:250
Drawn by NG
Checked by FG

Job No. 0053810
Date FEB 2023
Rev P02

Drawing No. ETC-BHE-ZX-XX-DR-CG-1007

Appendix A Groundwater Level Monitoring Proposals

Groundwater level measurement

- Measurement and recording of groundwater levels with a dip meter (i.e. not sampling for chemical analysis).
- Prior to the start of grouting:
 - An initial 2-week programme of “baseline” monitoring. This will involve measurement and recording of the groundwater level from each of the eight wells (see ETC-BHE-ZX-XX-DR-CG-1009 for locations, installation details presented below in Table 5) on three occasions per week.
- During grouting:
 - Measurement and recording of groundwater levels with a dip meter carried out at the beginning and end of every working day from each of the eight monitoring wells (see ETC-BHE-ZX-XX-DR-CG-1009 for locations, installation details presented below in Table 5).
- Provision should be made for additional monitoring in areas where grout takes are higher than expected and / or where there is a consistent and suspect rise in groundwater levels. In such circumstances monitoring of groundwater levels in relevant wells (i.e. wells in vicinity of grout injection) should be undertaken at hourly intervals for up to one day [Note: Other management action will also be undertaken in such circumstances and will be detailed within the selected contractor’s method statements];
- At the completion of the works, all groundwater level monitoring data to be provided to form a part of the Contractor’s Completion Report; and
- All boreholes to be decommissioned upon completion of the improvement works (in accordance with EA guidance [15]).

Table 5 Groundwater level monitoring installations

Borehole	Ground level (m OD)	Response Zone top (m OD)	Response Zone bottom (m OD)	Response zone in mbgl	Installation type	Additional installation detail
BH22/01	+60.55	+18.55	+8.55	42 - 52	Deep	All wells include two installations, ensure deeper installations are used as these target the Coal Measures (Secondary Aquifer). Baseline readings to be obtained followed by daily monitoring during grout works.
		+59.55	+56.55	1 - 4	Shallow	
BH22/02	+60.55	+30.55	+20.55	30 - 40	Deep	
		+59.55	+57.55	1 - 3	Shallow	
BH22/03	+60.85	+10.85	-1.15	50 - 62	Deep	
		+59.85	+57.85	1 - 3	Shallow	
BH22/04	+60.6	+30.6	+20.6	30 - 40	Deep	
		+59.6	+55.6	1 - 5	Shallow	
BH22/05	+60.95	+30.95	+20.95	30 - 40	Deep	
		+59.95	+56.95	1 - 4	Shallow	
BH22/06A	+60.6	+20.6	+10.6	40 - 50	Deep	
		+59.6	+56.6	1 - 4	Shallow	
BH22/07	+61.0	+31.0	+21.0	30 - 40	Deep	
		+60.0	+57.0	1 - 4	Shallow	
BH22/08	+61.15	+21.15	+11.15	40 - 50	Deep	
		+60.15	+53.15	1 - 8	Shallow	

Surface water inspection

- Visual inspection and recording of quality of the surface water at two locations (see Figure 2) in conjunction with the groundwater level monitoring. That is twice a week for the 2-weeks prior to the grouting works and twice a day during the works – with provision for additional inspection;
- The surface water monitoring record shall consist of a photo and note of condition at each location (IP 1 and IP 2) on every occasion; and
- At the completion of the works, all surface water condition monitoring records to be provided to form a part of the Contractor's Completion Report.

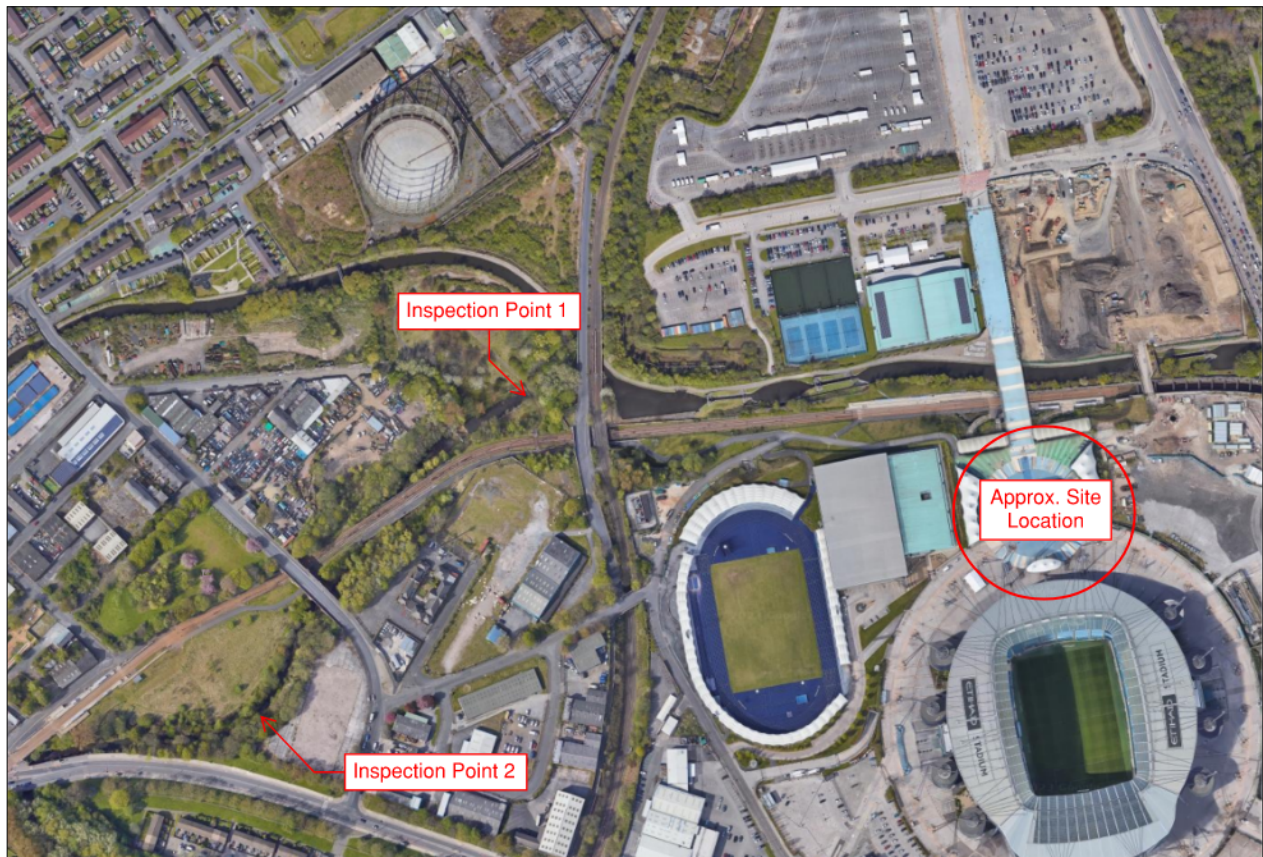


Figure 2 Extract from Google Earth showing surface water inspection points up and down stream of the Site.

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