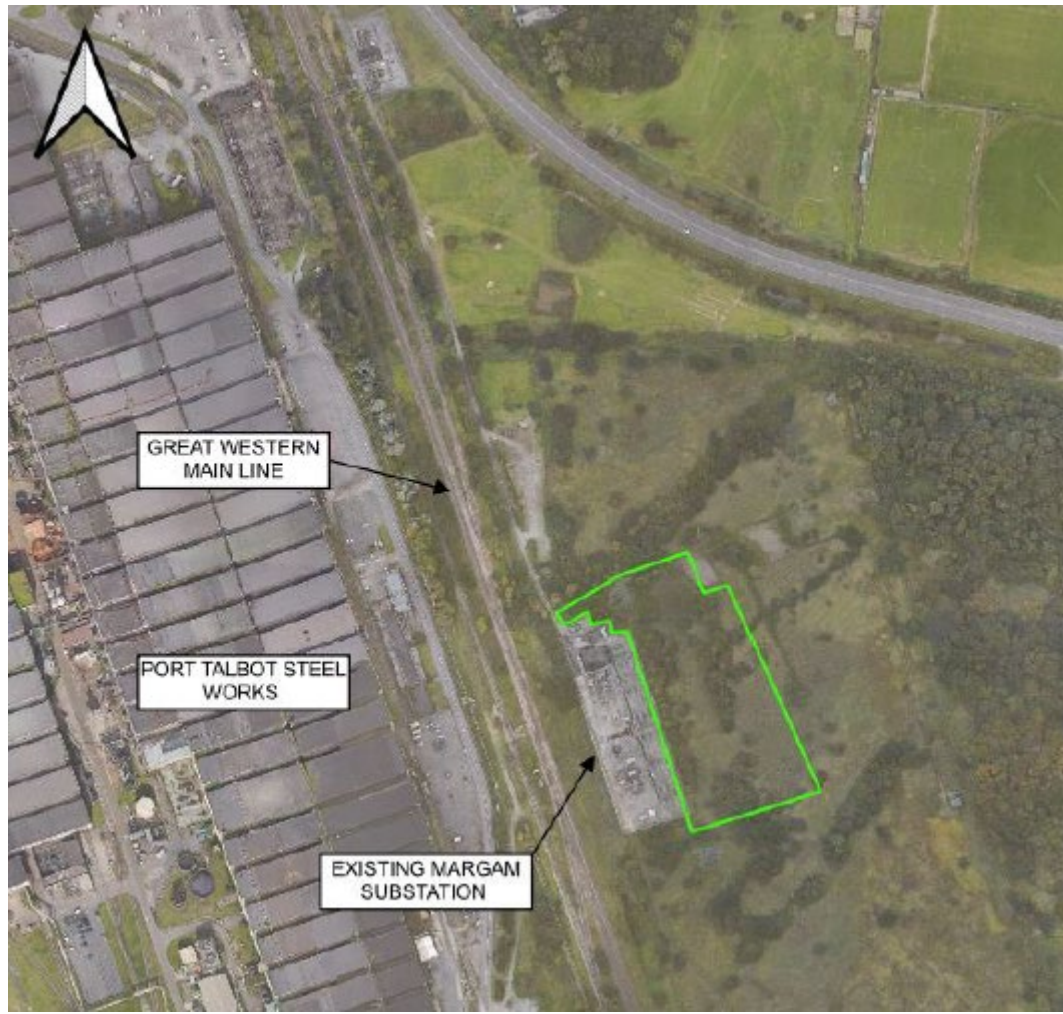


Margam Substation

Technical Note: Risk Assessment for Proposed Foundation Technique

Risk Assessment for Proposed Foundation Technique

Margam Substation



Revision	Prepared By:	Approved	Date	(LOR) Approved	Date
P01	James Croydon	Joe Curtis	29/08/25		

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1 INTRODUCTION

The proposed foundation technique at Margam Substation, herein referred to as ‘the site’ will be Displacement Auger Piling (DAP) and Continuous Flight Auger (CFA) piles.



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This technical note has been produced to undertake a risk assessment of the potential pollution scenarios that the foundation technique may present, and make recommendations, where necessary, to address potential unacceptable risks identified to the underlying soils and groundwater at the site based on the findings of the BakerHicks Margam Substation Ground Investigation Report MARPT-BHK-01-XX-RP-G-090001.

As part of the requirements of the planning permission, prior to the commencement of piling or foundation works, a piling risk assessment (PRA) shall be submitted to and approved by the local planning authority. The piling risk assessment shall assess the potential risks to human health, groundwater, and the stability of the ground, particularly in relation to any known or suspected contamination on the site. The assessment shall include:

1. A detailed review of ground conditions, including existing contamination reports and geotechnical data.
2. An evaluation of the potential for the migration of contaminants because of piling or other intrusive groundworks.
3. Identification of appropriate piling techniques to mitigate risks to human health, controlled waters, and the wider environment and the reasons for proposing this method.
4. A strategy for monitoring and mitigating any identified risks during the construction process. All piling works shall be carried out in each construction phase in accordance with the approved PRA and associated mitigation measures.

2 RELEVANT GEOLOGY AND GROUND CONDITIONS

2.1 Superficial Deposits

The underlying ground conditions encountered generally comprised thin layers of silt and clay overlying a continuous deposit of peat. These were in turn underlain predominantly by cohesive glacial till and fine to coarse gravels. The cohesive alluvium superficial deposits were encountered in all exploratory boreholes and were encountered at a depth of 1.10mbgl – 5.4mbgl. The Cohesive Tidal Flat Deposits (TFD-C) were encountered in all exploratory positions apart from TP105, TP105A and TP105B beneath the topsoil to depths between 1.10m and 5.40m bgl. It was typically described as very soft to soft blueish grey slightly sandy CLAY and very soft to soft blueish grey slightly sandy CLAY with occasional roots or pockets of peat between 15mm and 100mm in size. A layer of peat was encountered which is geologically part of the Tidal Flat Deposits but has been separated out as part of the interpretation due to its geotechnical properties. The peat layer was encountered in all exploratory positions apart from BH105, TP105, TP105A and TP105B either below or within the cohesive element of the Tidal Flat Deposits. The peat extended to proven depths between 3.50m and 5.80m bgl. It was typically described as spongy dark brown fibrous & pseudo fibrous PEAT, occasional roots and wood fragments also recorded.

The granular glacial deposits were encountered in all the borehole positions but was not recorded in any of the machine excavated trial pits due to their termination depth. This material was largely encountered below the TFD-C and Peat layer. Within 3no. boreholes (BH108, BH110 & BH111) this material was identified below the Cohesive Glacial Till deposits. It's likely that this granular material represents a glacial meltwater channel within the wider Cohesive Glacial Till deposit. The Granular Glacial Till deposits extended to a proven depth between 6.00m and 8.60m bgl. This material was typically described as:

- Medium dense dark brown slightly sandy GRAVEL with a low cobble content of subrounded sandstone and quartzite. Gravel is subangular to subrounded fine to coarse of sandstone and quartzite.
- Dense dark brown sandy GRAVEL with a low cobble content of subrounded sandstone and quartzite. Gravel is subangular to subrounded fine to coarse of sandstone and quartzite.



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Glacial Till Deposits (Cohesive) - This material was encountered within all borehole positions but was not recorded within any of the machine excavated trial pits due to their termination depth. The Cohesive Glacial Till deposits were encountered beneath the Granular Glacial Till deposits except within 3no. boreholes (BH108, BH110 & BH111) where they are recorded beneath the Tidal Flat Deposits and again beneath the Granular Glacial Till deposits. The Cohesive Glacial Till deposits extended to a proven depth between 11.90m and 13.30m bgl. This material was typically described as:

- Firm brownish grey slightly sandy slightly gravelly CLAY with occasional sand/gravel lenses up to 200mm thick. Gravel is subangular to subrounded fine to coarse of sandstone and rare coal.
- Stiff greyish brown/dark brown slightly sandy gravelly CLAY. Gravel is angular to subangular fine to coarse of sandstone and quartzite.
- Very stiff brownish grey slightly sandy gravelly CLAY. Gravel is angular to subangular fine to coarse of sandstone.

There was one entry within BH107 between 4.50m and 5.40m where this material is recorded as “Very soft dark brown slightly gravelly sandy CLAY. This is not viewed as representative of this material.

2.2 Solid Geology (Bedrock)

The main bedrock consists of coal measure formations with a weathered top. The weathered top was encountered within all borehole positions but was not recorded within any of the machine excavated trial pits due to their termination depth. This material was encountered beneath the Cohesive Glacial Till deposits and extended to a proven depth of between 14.40m and 18.80m bgl. This material was typically described as:

- Extremely weak grey MUDSTONE, recovered as angular to subangular fine to coarse gravel.
- Extremely weak dark grey MUDSTONE with occasional coal fragments up to 15mm in diameter.
- Stiff grey slightly sandy gravelly CLAY with many mudstone lithorelics up to 100mm in size.

The main Coal Measures formation was only encountered within 2no. exploratory positions: BH107 & BH109. This was encountered immediately below the weathered coal measures and extended to borehole termination depths of 49.50m bgl. This unit was encountered at 18. This unit was encountered as interbedded siltstones and mudstones which were typically described as:

- Medium to Very Strong SILTSTONE with rare very strong ironstone nodules.
- Medium to Very Strong SILTSTONE with occasional pyrite crystals and gypsum veins.
- Extremely/Very weak to Medium Strong MUDSTONE.

One entry of coal was logged within BH109 at 42.55m bgl with a thickness of 0.25m bgl. As part of the wider Phase 1 GI works intact coal was logged within the following boreholes associated with earlier options for the Margam Substation:

- BH101 approximately 110m north of the site, coal logged at 14.50m bgl with a thickness of 0.35m
- BH104 approximately 40m east of the site, coal logged at 15.70m bgl with a thickness of 1.40m.
-

It should be noted that BH101 and BH104 are located on the northern side of the thrust fault (Section 2.3.3) present north of the site. Therefore the encountered coal seams appear at significantly shallower depths than those recorded within BH109.

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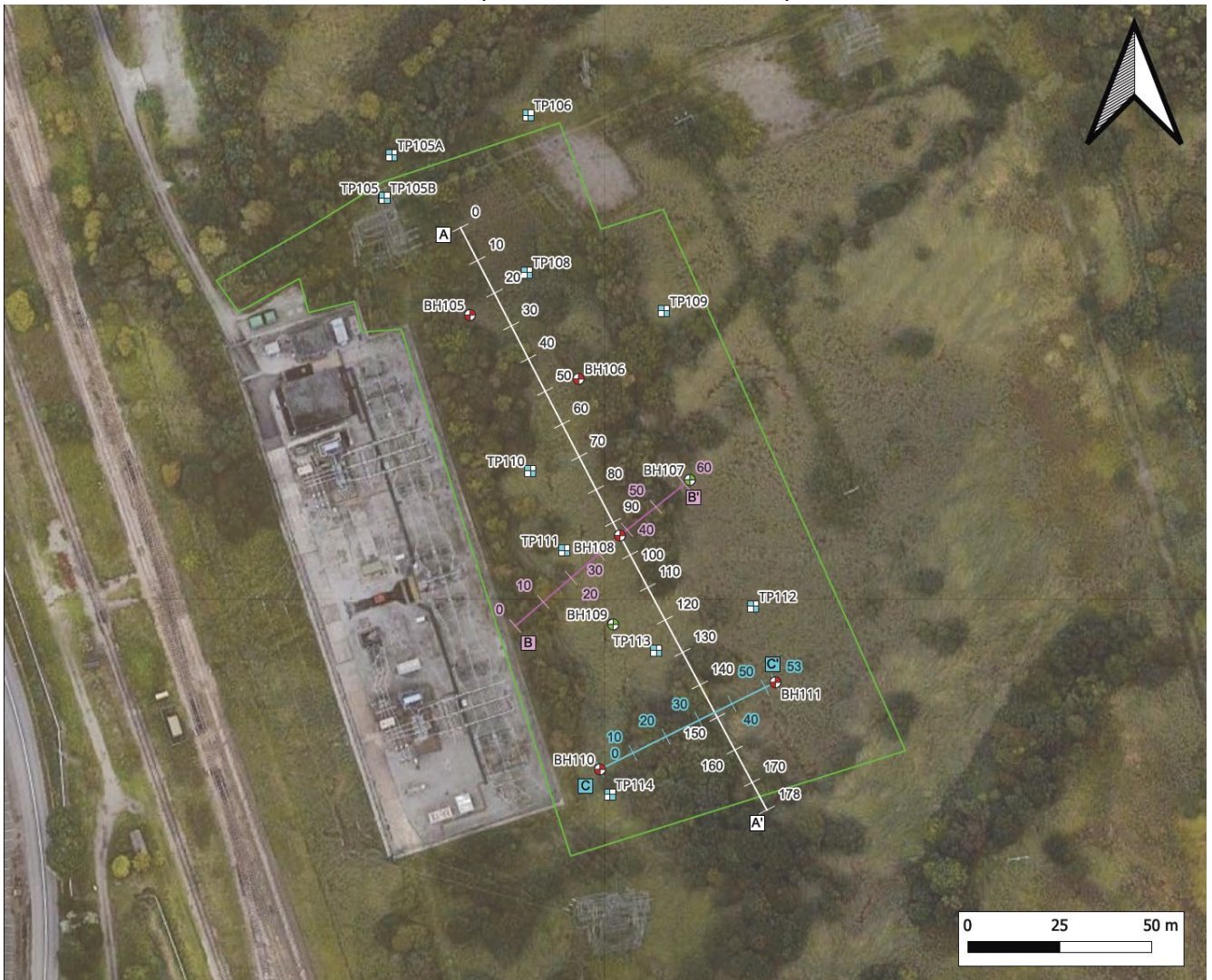


Figure 1: Cross-Section Layout Drawing

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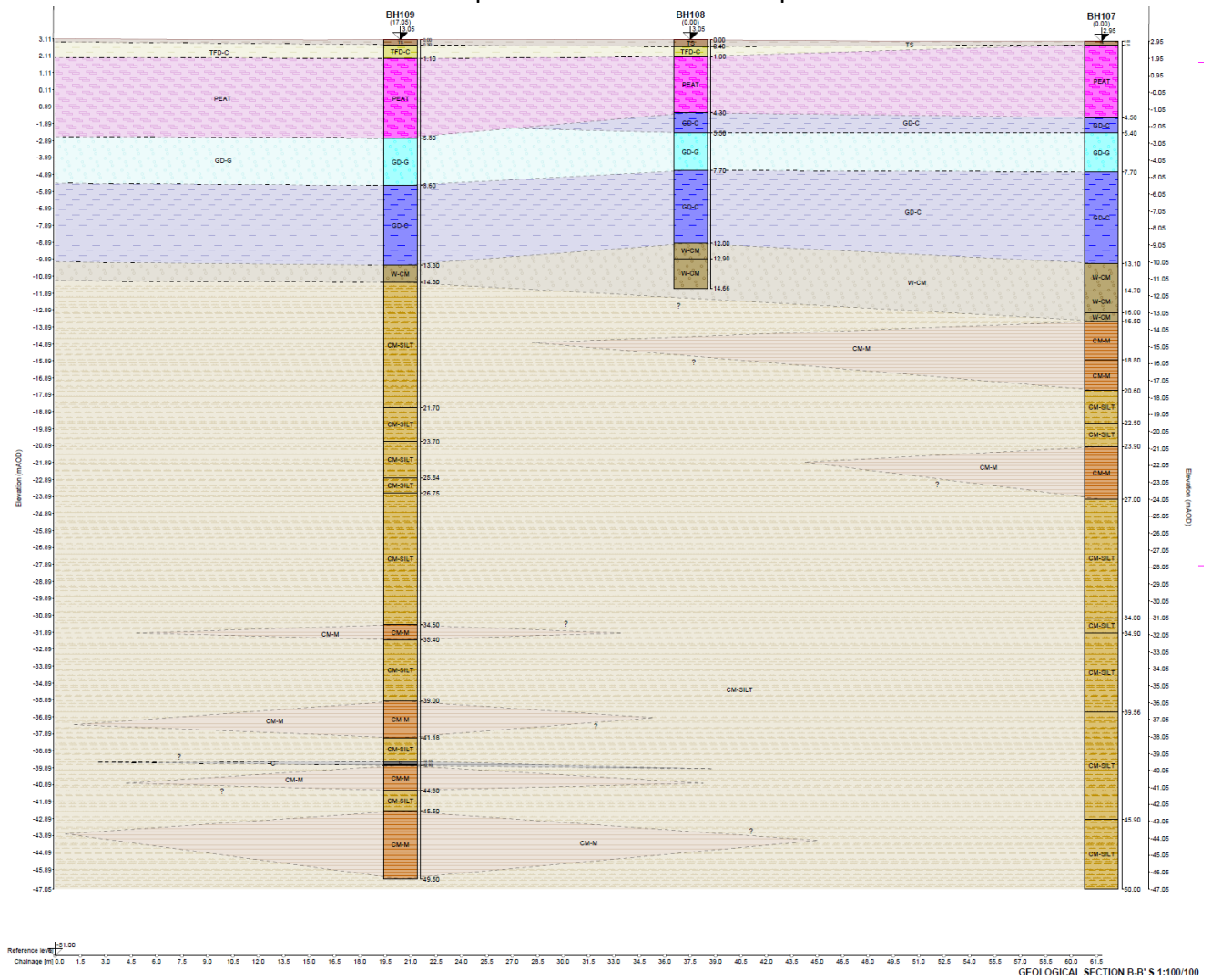


Figure 4: Section B-B'

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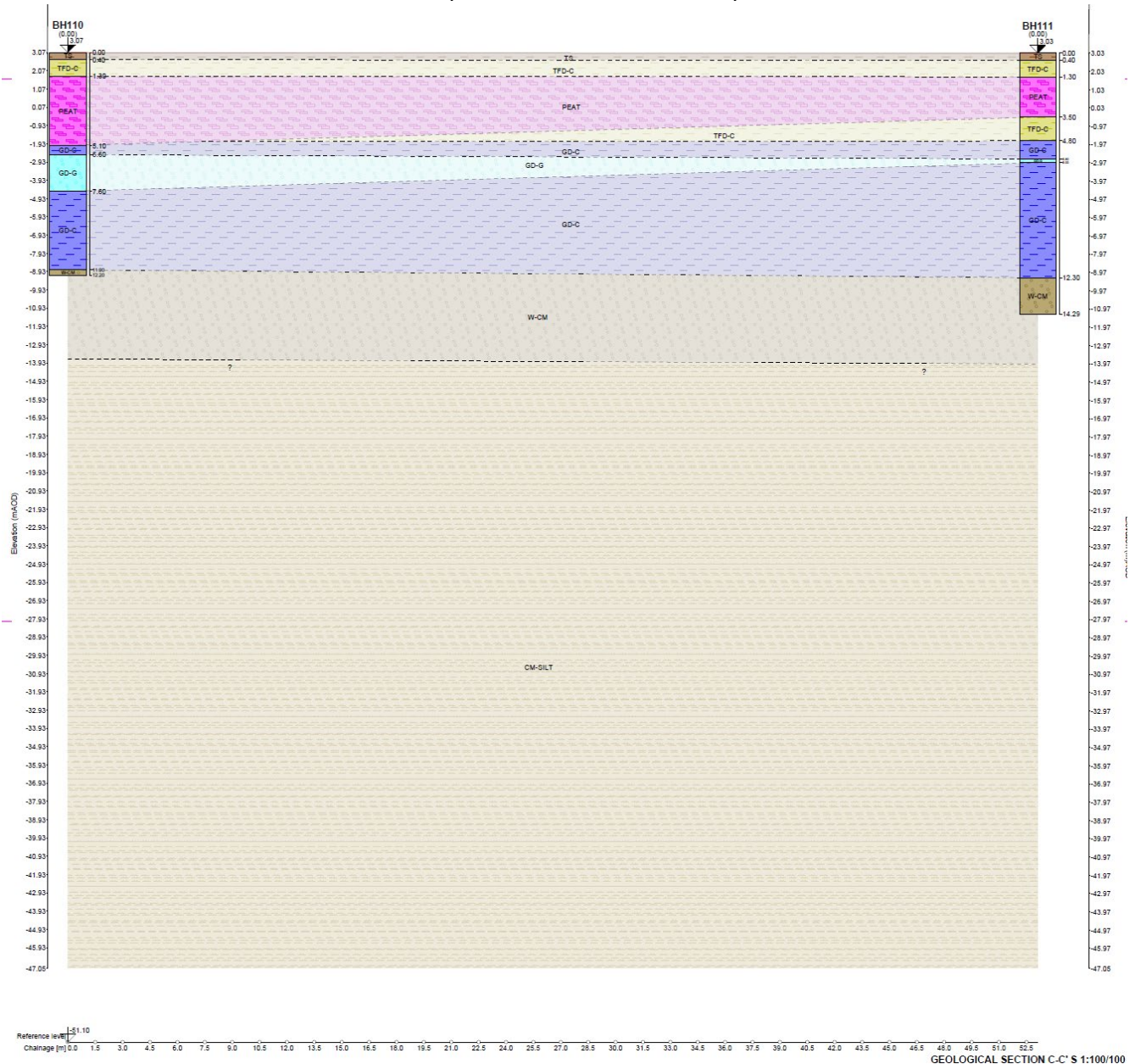


Figure 5: C-C'

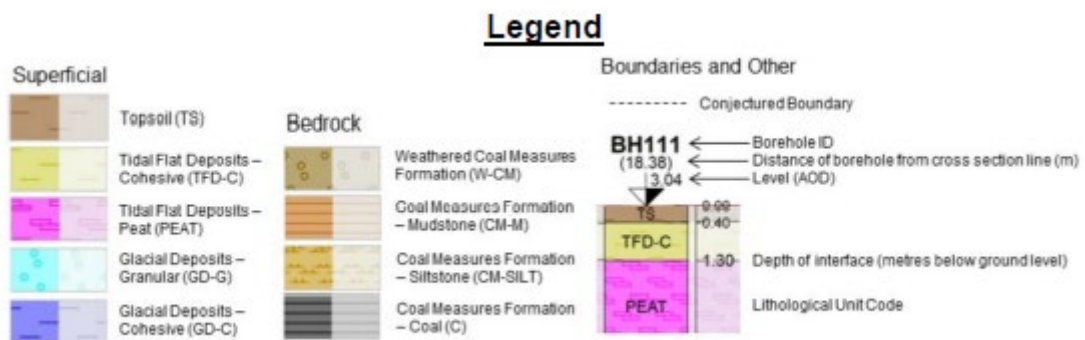


Figure 6: Cross-section Key

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2.3 Ground Water

Groundwater was observed during the ground investigation within the trial pits and boreholes. Figure 7 summarises the groundwater strikes with respect to the strata.

Exploratory Position	Strata	Strike		After 20 mins – Boreholes only		Comments
		Depth (mBGL)	Level (mAOD)	Depth (mBGL)	Level (mAOD)	
BH105	Topsoil	0.20	2.84	0.20	2.84	
BH105	Granular Glacial Deposits	5.00	-1.96	0.80	2.24	Sub Artesian
BH106	Topsoil	0.00	3.15	0.00	3.15	
BH106	Granular Glacial Deposits	4.70	-1.55	2.10	1.05	
BH107	Granular Glacial Deposits	5.40	-2.45	-0.46	3.41	Artesian
BH107	Coal Measures	21.00	-18.05	14.30	-11.35	
BH108	Granular Glacial Deposits	5.80	-2.75	-0.45	3.5	Artesian
BH109	Topsoil	0.10	2.94	0.00	3.04	
BH109	Granular Glacial Deposits	6.00	-2.96	-0.12	3.16	Artesian
BH110	Topsoil	0.00	3.07	0.00	3.07	
BH110	Granular Glacial Deposits	6.00	-2.93	1.90	1.17	
BH111	Topsoil	0.00	3.03	0.00	3.03	
BH111	Granular Glacial Deposits	5.80	-2.77	4.90	-1.87	
TP105A	Made Ground	0.70	2.965	-		Water standing on completion of excavation
TP105B	Made Ground	0.65	2.965	-		

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Exploratory Position	Strata	Strike		After 20 mins – Boreholes only		Comments
		Depth (mBGL)	Level (mAOD)	Depth (mBGL)	Level (mAOD)	
TP108	Tidal Flat Deposits – Cohesive	1.65	1.36	-		
TP109	Tidal Flat Deposits – Peat	1.45	1.59	-		
TP110	Tidal Flat Deposits – Peat	2.60	0.46	-		
TP111	Tidal Flat Deposits – Peat	2.30	0.76	-		
TP112	Tidal Flat Deposits – Cohesive	0.70	2.27	-		
TP113	Tidal Flat Deposits – Peat	1.60	1.48	-		
TP114	Tidal Flat Deposits – Peat	1.20	1.95	-		

Figure 7 Water Strikes

In addition to the groundwater level, some seepages were recorded within the topsoil and made ground at the following depths:

- TP105 at 0.50m bgl within the made ground, this was noted to have an oily sheen.
- TP106 at 0.20m bgl within the topsoil.

Due to the shallow groundwater, artesian and sub-artesian ground water conditions encountered during the GI, only 1no. borehole was installed with a gas and groundwater monitoring standpipe for further monitoring after the completion of the GI. This is because in boreholes with artesian conditions needed to be sealed to prevent groundwater flowing to surface. These boreholes were fully sealed with bentonite pellets. It is possible that the groundwater is tidally connected however conclusive evidence of this was not found as it is unlikely to have significant bearing on the design.

2.4 Land and Water Quality

During the investigation samples of the ground were taken and tested for significant contaminants in accordance with the current best-practice guidance for the assessment of land contamination as contained in the LCRM. From the CLEA model worst case guideline values have been produced. Soil samples were obtained from the site during the ground investigation works and subjected to laboratory analytical testing in order to inform the assessment of the risks posed to human health (construction workers, future site users), and controlled waters from the presence of potential contaminant sources. Total soil chemical results were directly compared to appropriate Human Health Assessment Criteria (HHAC) LQM/CIEH S4UL and DEFRA C4SL.

Soils have been screened against a commercial land use based on the intended site development as an industrial



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facility (proposed new GIS substation) HHAC have been formulated with suitable consideration to associated pollution linkages, comprising inhalation, ingestion and dermal contact with soil / dust and inhalation of vapours associated with volatile compounds. Of which there were 42 sample taken across the site for testing.

All 42no. samples subjected to laboratory testing returned results below the adopted screening criteria for commercial LQM/CIEH S4UL thresholds. Screening of 42no. samples for asbestos content did not return any positive results. As a result, it is considered that the soils collected from the near surface do not have the potential to present a significant risk based on the proposed commercial end use. Localised Total Petroleum Hydrocarbons were recorded within location TP115 0.2m bgl. Whilst the result falls below the adopted screening value total TPH was recorded with a concentration of 1,400mg/kg for chain length C21-35.

Groundwater samples were taken and sent to a lab for testing. The results have been compared against UK Drinking Water Standards, WHO Guidelines for Drinking Water Quality (4th Edition 2011) and Environmental Quality Standards to provide a conservative assessment of the potential risk to sensitive receptors.

Leachate testing was completed on 6no. samples from across the site to provide an assessment of risk associated with near surface concentrations. Leachate testing by the test method is considered to represent a worse case assessment of concentrations, such that screening of results to water quality standards can be deemed precautionary. However, screening of leachate samples returned results at the limit of detection or below the adopted screening criteria.

Based on the above testing, with both groundwater and leachate samples returning results below the adopted screening criteria or limit of detection it is considered that near surface concentrations within the development area do not represent a significant risk to Controlled Waters.

2.5 Ground Gas

Ground Gas Risk Assessment should be completed in general accordance with current British Standards and technical guidance, BS8576:2011, BS8485:2015+A1:2019 and CIRIA 665. The empirical semi-quantitative approach is based on the calculation of Gas Screening Values (GSV), as defined by BS8485 (Ref [41]). GSV are calculated by via assessment of gas concentration and gas flow rate, whilst considering of influencing factors. CIRIA 665 (Ref [42]) states that typically six monitoring visits should be undertaken over a period of three months, with some visits to be undertaken in atmospheric conditions below 1000 mBar.

2no. boreholes (BH111 and BH112) were installed with gas and groundwater instrumentation for monitoring purposes. Due to the presence of shallow groundwater, response zones were flooded such that it was not possible to complete ground gas screening during the monitoring period.

Given the low likelihood of migration from off-site sources due to the cohesive nature of the shallow superficial deposits and high groundwater table limiting lateral migration, it is considered that the only significant potentially active SPR linkage for ground gas at the site is the peat and organic soils below the site. Given these are a low generation potential and, due to the presence of ground water, consistently flooded it is considered highly unlikely that significant flows of ground gas would be generated within the organic stratum.

Due to the shallow groundwater and artesian aspects at the site restricting ground gas monitoring it is considered that an assumption of a Characteristic Situation 2 protective measure may be undertaken to eliminate residual risk from the ground gas sources on the site.



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3 PROPOSED FOUNDATION CONSTRUCTION METHODOLOGY

3.1 Displacement Auger Piles

A DAP pile will be bored using a hollow stem auger and rods in one continuous downward movement to the founding depth of the pile. Concrete will then be pumped through the hollow stem of the auger at controlled pressure and the auger will be slowly withdrawn with rotation kept to a minimum. Once the auger is fully withdrawn and the pile is concreted, a reinforcement cage will be placed through the freshly placed concrete.

DAP is a displacement piling technique which relies on the auger consolidating the weak ground condition to the shaft of the pile. Displacement of the soil surrounding the pile is typical we expect to see radial or vertical soil movement due to the consolidation of soils. There will be minimal excavated soils brought to the surface and the only arising which will need to be cleared are the small amount due to the displacement of the ground. The presence of the hollow stem auger during boring and the injection of concrete is undertaken at pressures greater than the head of groundwater so that there is no groundwater flow into the void. The concrete is cast in-situ forming an irregular seal with the surrounding soil.

3.2 Continuous Flight Auger Piles

A CFA pile will be bored with a penetration rate of 100mm/turn using a hollow stem auger in one continuous downward movement to the founding depth of the pile. Concrete will then be pumped through the hollow stem of the auger at controlled pressure and the auger will be slowly withdrawn with rotation kept to a minimum. Once the auger is fully withdrawn and the pile is concreted, a reinforcement cage will be placed through the freshly placed concrete.

CFA is a non-displacement piling technique which relies on the retention of soil on the auger flights to provide support to the surrounding soil until the auger is withdrawn and concrete injected. Displacement of the soil surrounding the pile is typically minimal with minimal radial or vertical soil movement, and excavated soils are brought to the surface on the rotating auger flights as soil arisings. The presence of the hollow stem auger flights during boring and the injection of concrete is undertaken at pressures greater than the head of groundwater so that there is no groundwater flow into the void. The concrete is cast in-situ forming an irregular seal with the surrounding soil.

3.3 Pile Scope

Figure 9 shows the splitting in piles based on the loads on the piles, all orange piles are currently design with a design load of 80kPa and are displacement piles. Green and blue piles highlighted on the drawing are indicated to be 200kPa and are considered now to be CFA piles

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Figure 9: Pile loads and layout.

4 PILING AND PENETRATIVE METHODS RISK ASSESSMENT

The recently published guidance from Cl:aire (Claire, 2025) provides a framework for assessing potential risks posed by piling and helpful descriptions of different pile foundations. This approach is followed with some of the text reproduced here to aid description. A pile foundation is a type of deep foundation. It comprises a slender column or cylinder made of materials such as concrete or steel which are used to support the structure and transfer the load to competent soils or rock at a desired depth (see Figure 10). They are used where the shallow soils are weak and/or compressible and cannot support foundation loads. Piles can support loads by end bearing onto a competent stratum, skin friction between soil and pile shaft or a combination of both.



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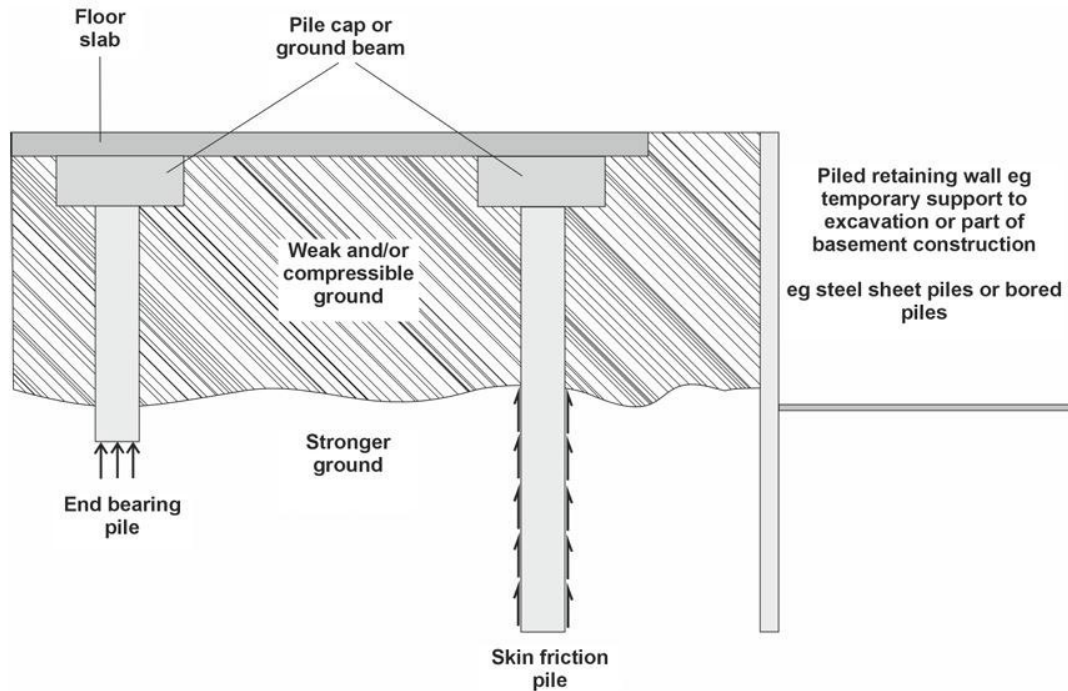


Figure 10 Examples of pile foundations (reproduced from Claire, 2025)

Piling, in certain circumstances, has the potential to create adverse environmental impacts when used on land affected by contamination or within groundwater source protection zones, as illustrated in Figure 4-2. There are also potential consequences to surface waters via groundwater.

However, the most recent guidance acknowledges that it is increasingly recognised that on many sites piling does not pose a risk of adverse effects to either groundwater or gas emissions because of site-specific factors.

The following risk assessment has been prepared to assess the potential risks from the use of DAP and CFA foundation techniques and to identify necessary mitigation measures. The assessment has been carried out using the risk assessment framework recommended within the National Groundwater and Contaminated Land Centre report NC/99/72¹.

The six pollution scenarios contained in that guidance have been considered individually, taking into account the site-specific sources, pathways, and receptors for each case.

4.1.1 Pollution Scenario 1

4.1.1.1 *Creation of pathways through an aquitard to allow potential contamination of an aquifer*

DAP and CFA piles are proposed across the site. Groundwater was recorded within the superficial deposits and this was separated from the lower ground water bodies by the presences of the cohesive glacial till which acted as an aquitard between the two water bodies.

DAP and CFA piles during installation will breach the base of these materials therefore a risk assessment has been undertaken to assess whether this would create a potential pathway for contamination into the underlying aquifer.



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The risk assessment for this scenario considers that:

- CFA piles minimise the creation of pathways as no open voids are created. During the continuous boring process, spoil is held on the auger flights which mitigates the potential for downwards migration of groundwater or spoil, and on completion of boring, concrete is pumped through the base of the auger whilst it is in and withdrawn from the ground.
- DAP Piles minimise the creation of pathways due to the Soil surrounding pile is densified and high stresses are induced when driving displacement piles. This increases with size of pile and magnitude of displacement. In most soils these stresses will tend to force the soil to close up around the pile shaft, which means that the development of preferential flow paths around the outside of the piles is, in general, unlikely.
- The concrete for this foundation technique therefore fills the whole void prepared by the auger while minimising the possibility of water flowing down the pile shaft.
- The piling contractor monitors the flow and pressure of the concrete supply to ensure no open voids are created, and this would be mitigated by restoring the pressure. Procedures and standard operating procedures are set up by the piling contractor to avoid this eventuality short of a plant breakdown.
- CFA piles do not push contaminated soil deeper into the ground as the soil is retrieved as spoil at the surface.
- DAP piles may potentially drag down contaminated materials as they penetrate underlying strata. Drag down may occur by pushing down of material at the tip of the auger. This risk is minimised using small diameter displacement piles which cut through or push material aside.
- There are a series of case studies where CFA piled foundations have been accepted by the regulator as the preferred foundation techniques in similar ground conditions as “the infill concrete is effectively impermeable and cast-in situ against the surrounding soil and formation of preferential pathways is not likely”¹.
- The works will be undertaken by a competent and experienced piling contractor with a good track record.

In consideration of the above, the DAP and CFA techniques are not considered to pose a significant risk to the underlying aquifer due to the introduction of new migration pathways.

4.1.2 Pollution Scenario 2

4.1.2.1 *Creation of preferential pathways through a low permeability surface layer, allowing migration of soil gas or contaminated vapours to the surface*

Ground gas assessment has been made across the sites which show that there is no considerable source of ground gas in the made ground due to absence of degradable material. There is low risk of carbon dioxide gas which would only provide a potential risk if allowed to collect in confined spaces which in the case of piling works would not occur and the resultant concreting of the piles would create a seal cutting off this pathway.



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4.1.3 Pollution Scenario 3

4.1.3.1 *Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface*

Contaminated soils may be brought to the surface as spoil materials during the installation of CFA piles; however, contact with arisings can be minimised via the use of plant to remove spoil to designated controlled areas at the site or within a contained vessel on site awaiting disposal at a suitably licensed facility. The speed at which the arisings are produced facilitates their safe and controlled removal. DAP piles minimise the interaction of site workers with the ground due to the minimal soil recovery of the technique as the soil is displaced rather than replaced.

In line with current guidance, site safety precautions will be undertaken, including the provision of suitable personal protective equipment (PPE) and the implementation of site safety procedures. All site works will be undertaken in accordance with the guidelines prepared by the Health and Safety Executive². It is not considered that significant risk due to contamination will be posed to site workers provided the detailed measures are followed at all times.

4.1.4 Pollution Scenario 4

4.1.4.1 *Direct contact of the piles with contaminated soil or leachate causing degradation of materials*

The proposed CFA and DAP piles will be formed of concrete designed to resist the concentrations of contaminants specific to the site, and therefore the risk to CFA and DAP pile durability is negligible. Appropriate design classes in accordance with BRE guidance will be selected. From the current report the ground conditions have been assessed and it has been deemed that DS-2 sulphate class and ACEC Class AC-2 grade concrete can be utilised.

4.1.5 Pollution Scenario 5

4.1.5.1 *The pushing of solid contaminants down into an aquifer during pile driving*

CFA piling is a non-displacement technique and is not considered to push contaminated soil deeper into the ground. Displacement of the soil surrounding the pile is typically minimal and there is minimal radial or vertical soil movement for CFA piles where spoil material from within the shaft is brought to the surface. Therefore, there is limited risk of solid contaminants being pushed down into the aquifer.

Small diameter DAP piles are considered to be low risk to the movement of solid contaminants due to the nature that they cut through the ground to displace material and push material aside.

4.1.6 Pollution Scenario 6

4.1.6.1 *Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout*

The concrete curing process is one in which minimal transfer occurs between the groundwater and the curing material, as demonstrated by the curing of concrete cubes within water tanks³.

The piling contractor monitors the flow and pressure of the concrete supply to maintain as close a balance as possible between the concrete injection pressure and water pressure to avoid migration of concrete into any more permeable horizons that might exist. By necessity concrete is installed at a certain elevated pressure with respect to water pressure to avoid laitance and necking effects.

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As the concrete is placed at the toe of the auger on withdrawal, only a small volume of concrete is under pressure at any one time. Therefore, it is considered that the installation process of the piles minimises the risk of migration of concrete into the surrounding groundwater.

5 MITIGATION MEASURES AND QUALITY ASSURANCE AND CONTROL

The selection of DAP and CFA technique mitigates the risks associated with the creation of pathways during foundation works. As outlined above, it is considered that the risk of pollution due to DAP and CFA piling to the proposed depths is low.

Notwithstanding this, the potential for 'failures' during the installation of the piles and control measures have been considered as outlined in Table 1 below.

² HSE (1991) *Protection of Workers and the General Public during the Development of Contaminated Land*. Reference HSG 66.

³ BSI (2011) *Testing concrete. Method for determination of water absorption*. BS1881-122:2011+A1:2020.

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Table 1: Potential Failure Scenarios and Mitigation and Control Measures for DAP & CFA Piling

Potential Scenario	Consequence and Potential Environmental Impact	Mitigation and Control Measures	Likelihood of Incident	Response Actions in Event of Incident
Interruption in flow of concrete when completing pile.	Below ground void created and potential creation of preferential pathway for contaminated material to migrate to underlying geology and aquifer.	Contractor has to ensure that a sufficient supply of concrete is available on site to complete scheduled pile. Flow of concrete injection is monitored and logged continuously by machine operator in cab during installation of pile. If interruption of flow occurs when auger has progressed into underlying shallow aquifer, natural soils and founding stratum, positive pressures of aquifer would reduce potential for downwards migration of contaminants into underlying aquifer.	Negligible	Auger withdrawal paused until concrete supply/flow is restored and pile is completed.
Concrete flow rate too low versus withdrawal rate of auger.	Below ground void potentially created / lower quality seal of concrete against surrounding soil created. Potential creation of preferential pathway for contamination within waste to migrate to underlying geology and aquifer	Flow rate and pressure of concrete injection will be monitored and logged continuously by machine operator in cab during installation of pile. If low flow rate occurs when auger has progressed into underlying shallow aquifer, natural soils and founding stratum, positive pressures of aquifer would reduce potential for downwards migration of contaminants into underlying aquifer	Negligible	Flow rate will be adjusted as required in accordance with piling contractor method statement to ensure flow rate remains within required limits. If mechanical failure leads to cessation of concrete flow, response action as outlined above will be undertaken.
Concrete flow rate too high versus withdrawal rate of auger.	None. High flow rate/pressure would still create good quality seal of concrete against surrounding soil.	Flow rate and pressure of concrete injection will be monitored and logged continuously by piling contractor during installation of pile.	Negligible	Flow rate will be adjusted as required in accordance with piling contractor method statement to ensure flow rate remains within required limits. If mechanical failure leads to cessation of concrete flow, response action as outlined above will be undertaken.
Obstruction is encountered before pile toe level is reached	None. Risk of encountering obstructions is considered very low due to finding of ground investigation; however, if encountered, they would be shallow and would not be in the natural soils so new pathway created into underlying aquifer.	Progression of auger will be continuously monitored by piling contractor during installation of pile.	Negligible	Pile progression will be terminated, and concrete injection undertaken to fill void and seal against surrounding soils as auger is withdrawn.

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Mechanical failure – auger becomes stuck in ground at toe level and cannot be withdrawn	Potential for groundwater seepage around auger and creation of preferential pathway into underlying geology and aquifer.	Soil arisings held on auger flight above base of auger mitigate the creation of a preferential pathway for groundwater migration around the auger and seal the void created by the auger as it progressed to depth. Sub-artesian groundwater pressures from shallow aquifer will be constrained by the unremoved soil on the auger flights. Progression of auger is continuously monitored by the piling rig operator during installation of pile and piling contractor to utilize appropriately sized rig based on ground conditions. Positive pressures of shallow aquifer would reduce potential for downwards migration of contaminants into underlying aquifer.	Very Low	Concrete injection undertaken to fill void at base and within central column of auger flights. Auger flight(s) and surrounding soil on flights will remain in-situ and location recorded.
Operator error – auger is removed without concrete injection	None. Void of between 600mm and 750mm diameter through Made Ground into underlying geology and potential creation of preferential pathway for contamination within waste to migrate to underlying geology and aquifer.	Creation of void unlikely as surrounding material will collapse into the void if the auger and overburden soils on auger flights are removed without injection of concrete, as the auger flights provide lateral support to surrounding soils. Positive pressures of shallow aquifer would reduce potential for downwards migration of contaminants into underlying aquifer.	Negligible	Pile location will be re-bored in the same location and concrete injected as per piling method statement within 24 hours.

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6 MITIGATION AND QA/QC

At this site, the assessments have shown that special precautions are not necessary to protect human health, controlled water and the wider environment. The procurement, installation, monitoring and QA/QC checks that would be expected with any piling contract will also ensure that the piles are installed as designed and provide the appropriate foundation solution. This will likely include integrity tests and load tests and verification of materials to ensure piles are not adversely affected by ground conditions.

6.1 CEMP

The works will be undertaken in accordance with the Construction Environmental Management Plans (CEMP) and incorporate on-going monitoring by the Environmental management team throughout the construction phase.

It will be the responsibility of the appointed Principal Contractor to ensure that the works are undertaken in accordance with any legal requirements. The Principal Contractor shall comply as necessary with the Construction (Design and Management) Regulations 2015 (CDM) and shall comply with all applicable pollution control regulations. The Principal Contractor shall obtain and keep current any necessary consent, authorisation, approval or permission.

The Principal Contractor shall, where relevant, undertake construction works in accordance with current guidance and good practice, including:

- Environmental Good Practice on Site Guidance (C811, fifth edition, Ciria, 2023);
- Planning Policy Wales (Llywodraeth Cymru Welsh Government, edition 12, Feb 2024);
- Control of Dust from Construction Sites (BRE DTi Feb 2003);
- British Standards 5228-1:2009+A1:2014: 'Code of Practice for noise and vibration control on construction and open sites – Noise';
- Institute of Lighting Professionals. Guidance Notes for the Reduction of Obtrusive Light. ILP GN01:2011; and Relevant pollution prevention guidance, such as set out at <https://www.gov.uk/guidance/pollution-prevention-for-businesses>

6.2 Arising Management

The Site will operate in full compliance with the Environmental Protection Act 1990, the Environmental Protection (Duty of Care) Regulations 1991, all other relevant legislative requirements and the CEMP. Wherever possible, a principle of reduce-reuse-recycle will be adopted. All arisings will be managed and re-used on site in accordance with the Materials Management Plan (MMP) and Peat Management Plan.

The peat arisings from the piling operations will be blended with other soil and rock materials and will not therefore be suitable for reburial. This material will need to be removed from site for disposal as waste at a suitably licensed facility.

6.3 Noise and Vibration

CFA and DAP will provide the smallest amount of Noise & Vibration compared to other techniques such as Rotary Bored Piling, or Driven Piling. As noted in the risk assessment section of this document there will still need to be

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monitoring implemented for vibration and movement of existing structures, as well as noise monitoring where directed in the construction noise assessment

Historical Vibration data Project	Peak Particle Velocity (PPV)	Distance away	Activity
Manchester Airport	0.950mm/s	9.8m	CFA drilling
Manchester Airport	1.725mm/s	3.0m	CFA drilling
Manchester Airport	0.875mm/s	2.0m	Rig tracking
Beckton STW	4.39mm/s	5.0m	Rig Tracking
Beckton STW	1.00mm/s	5.0m	CFA drilling
Shepperton Studios	0.50mm/s	10.0m	DAP drilling
Shepperton Studios	1.85mm/s	10.0m	Rig Tracking

Historical Noise Data Project	Average Sound Level (dB)	Distance away	Activity
Shepperton Studios	75.1dB	10.0m	DAP drilling
Shepperton Studios	70.9dB	20.0m	DAP drilling
Shepperton Studios	73.0dB	20.0m	Concrete Pumping
Shepperton Studios	68.6dB	60.0m	DAP drilling

7 REASSURANCE MONITORING

A watching brief will be maintained by the piling contractor during DAP and CFA operations to provide early warning if unexpected contamination is encountered. Waste management practices and health and safety considerations during handling of pile arisings is also required to enable appropriate management of material and minimise health and safety risks to piling operatives.

8 FOUNDATION WORKS WATCHING BRIEF

It is recommended that a watching brief is maintained by the contractor during the foundation works – ie pile caps and slabs. This will focus on areas of known contamination, based on observation from the investigations. Where unexpected contamination, such as material of an unusual colour or odour is encountered during foundation works then the following discovery strategy is recommended.

- Works to cease in that area.
- Where gross contamination (e.g. free product, asbestos containing material) is encountered, segregate the material, cover and store on hard standing or sheeting, fence off from other areas and check measures are in place to safeguard the piling operatives and groundworks contractor.
- Notify the Environment Agency, as appropriate, to agree the appropriate mitigation measures, which is likely to comprise the following:
 - Obtain soil samples for laboratory analysis and where practicable, excavate impacted soils and test the sides and base of the excavation to demonstrate that the full area of contamination has

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been excavated.

- On receipt of chemical test results, the soils may be appropriately classified for recovery, treatment or disposal, where appropriate, and dealt with accordingly. Grossly contaminated material such as oily material will not be re-used in the scheme.
- To facilitate waste disposal or potential re-use of materials excavated, soils should be segregated and stockpiled depending on their soil classification.
- Detailed records of the stockpile(s) size, source, location and fate should be kept and regularly updated to allow materials to be easily tracked from excavation until leaving the site or re-used, as appropriate.
- Records of excavated areas and the results of chemical testing should be incorporated within the final verification report for the scheme.

9 WASTE MANAGEMENT

The arisings generated through the piling operations will require appropriate management and stockpiling, according to material type and contamination observations, prior to subsequent testing and removal, likely for off-site disposal to an appropriately licensed facility.

8.0 HEALTH & SAFETY

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive² and CIRIA Reports 132⁴ and C650⁵. All works should also be carried out in accordance with the Contractor's Construction Health and Safety Plan and, with regards to the piling operations, the health and safety documentation. In addition, current asbestos regulations⁶ and guidance^{7,8} should be followed.

During the development, precautions should be taken to minimise exposure of workers to harmful substances including the potential for asbestos. Attention should also be given to restricting potential off-site nuisances such as dust and odour emissions. Such precautions should include, but not be limited to:

Personal hygiene, washing and changing procedures.

Adequate personal protective equipment, including disposable overalls, gloves and particulate filter masks where required.

Measures to avoid surface water ponding and positive collection and disposal of all on-site run-off.

Regular cleaning of all site roads, access road and public highways, also including dust suppressions methods (e.g. water spraying) if necessary.

All waste haulage vehicles should be covered when leaving site to minimise the release of airborne particulates.

⁴ Steeds J.E., Shepard E., Barry D.L. (1996) *A guide for safe working on Contaminated Sites*. CIRIA Report 132.

⁵ CIRIA (2005). *Environmental Good Practice – Site Guide, 2nd Edition*. CIRIA Report C650.

⁶ Health and Safety Executive (2012) *The Control of Asbestos Regulations*.

⁷ Health and Safety Executive (2006) *Asbestos: The Licences Contractor's Guide*. Guidance Note HSG247

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⁸ Health and Safety Executive (2006) *Work with Material Containing Asbestos*. Control of Asbestos Regulations 2006 Approved Code of Practice and Guidance.