



Foundation Works Risk Assessment

Rochdale Road, Manchester

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Comments

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1. Introduction

1.1 Objectives

McGoff Construction Limited (Client) instructed Waterman Infrastructure & Environment Limited (Waterman) to prepare a Foundation Works Risk Assessment (FWRA) for the proposed residential redevelopment of land at Rochdale Road, Manchester (hereafter referred to as “the Site”).

The purpose of the FWRAs to set out the potential impacts the proposed piling works will have on groundwater and other potential receptors, and the mitigation measures required to prevent an unacceptable level of risk being present.

This FWRA has been prepared in accordance with 2001 Environment Agency (EA) guidance Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, Land Centre report NC/99/73, and 2002 EA Booklet Piling into Contaminated Sites.

This report is informed by and should be read in conjunction with the documents included in Appendix B.

1.2 Proposed Development

The Proposed Development is defined as:

‘The Erection of a part 11, part 13 storey building to form residential apartments (Use Class C3a) together with the erection of two blocks of 3 storey duplexes (Use Class C3a) to form 237 residential homes in total with associated commercial floor (Use Class E) (132 sqm), basement car parking, landscaping and public realm, and associated engineering and infrastructure works following demolition of existing buildings and structures’.

The consented development Drawings is included in Appendix A

1.3 Planning Context

The Scheme gained planning consent (131708/FO/2021) in 2021. Planning condition 3 is relevant to deep foundations and states the following:

Condition 3: Piling

Prior to the commencement of the development, details of the method for piling, or any other foundation design using penetrative methods, for the development shall be submitted for approval in writing by the City Council, as Local Planning Authority. The approved details shall then be implemented during the construction of the development.

Reason - Piling or any other foundation using penetrative methods can result in risks to potable supplies (pollution/turbidity, risk of mobilising contamination) drilling through different aquifers and creating preferential pathways. It is therefore necessary to demonstrate that piling will not result in contamination of groundwater. In addition, piling can affect the adjacent railway network which also requires consideration pursuant to policies SP1, EN17 and EN18 of the Manchester Core Strategy (2012).

The information in this report has been prepared to support the discharge of planning condition 3 and should be submitted to the Manchester City Council for approval.

1.4 Previous Reports

The previous reports have been prepared which are relevant to the consented scheme and provide background details to this report.

Table 1: Previous Reports Relating to the Site

Title	Author	Date	Reference
Phase 1 Geo-Environmental Site Assessment	E3P	12/2018	12-922-R1
Site Investigation Proposal	Waterman	September 2022	WIE19453-100-TN-1.2.1-GI Scope
Generic Quantitative Risk Assessment	Waterman	December 2022	WIE19453-100-R-2.2.1-GQRA
Remediation Strategy	Waterman	December 2022	WIE19453-100-R-3.1.2-RemStrat

2. Environmental Site Setting

This section provides an overview of the Site's environmental setting as identified by intrusive investigations across the area.

2.1 Geology and Hydrogeology

A summary of the geology and hydrogeology across the Site, identified by previous ground investigation works is detailed in Table 2.

Table 2: Site Geology and Hydrogeology

Stratum	Thickness (m)	EA Classification	Groundwater Range Within Stratum (m BGL)
Tarmac	0.07	Not classified	N/A – not identified as a continuous groundwater body across the Site
Concrete	0.1-0.2	Not classified	N/A – not identified as a continuous groundwater body across the Site
Made Ground (Granular)	0.9-7.8	Not classified, may locally contain shallow water	5.8m to 6.5mbgl
Made Ground (Cohesive)	1.1	Not classified	N/A – not identified as a continuous groundwater body across the Site
Glacial Till	13.0-19.2	Unproductive Strata	N/A – not identified as a continuous groundwater body across the Site
Sand	1.3-2.8	Unproductive Strata	N/A – No groundwater present within this stratum
Sandstone	From 15.00 - 26.0m (unproven)	Principal Aquifer	Possible water Level

Limited groundwater was recorded during the ground investigation. The exception to this was boreholes BH102, BH103 and BH104 between depths of 5.80m and 6.5mbgl. Strong hydrocarbon odour associated with the groundwater was encountered in these locations.

Where the Glacial Till has been excavated at the Site, groundwater is encountered within the Made Ground contained above the Glacial Till surface. The groundwater level is dictated by the depth to the surface of the Glacial Till. The groundwater is likely to be perched and discontinuous across the Site, as evidenced by dry boreholes recorded at BH101 and BH104. Groundwater levels recorded during the post WIE19453-100-R-2.2.1-GQRA Generic Quantitative Risk Assessment works monitoring indicates the groundwater will migrate locally to the north-east from BH105 towards BH102.

6No. groundwater level monitoring rounds will be completed as part of the post fieldwork monitoring.

It should be noted that borehole BH107 and BH105 are located off-site to the north. The topographic level of the adjacent site is approximately 5m lower than the subject Site.

2.2 Potential Contamination Sources

The Generic Quantitative Risk Assessment (Report Ref: WIE19453-100-R-2.2.1-GQRA), issued in December 2022, identifies the potential for contamination to be present at the Site associated with the former mechanic's garage and gas works. The assessment included testing of soil and groundwater samples to confirm the levels of contamination present and the associated risk present at the Site. A program of gas monitoring is currently ongoing.

During the investigation, visual and olfactory evidence of contamination within the soil were noted. Soil samples were subject to screening using PID (Photo Ionization Detector), which readings were exceeding values between approximately 5ppm to 180ppm in BH105, BH102, BH103, BH104 and BH10 at depth of 5.00m to 7.00m bgl. Strong hydrocarbon odour was identified in those locations.

Other location as BH102, BH104, BH107, WS102, WS104 and TP16 no contamination observation was noted but PID readings between 2.5ppm and 51 were recorded at depth of ground level to 3.0m except for BH107 which depth was 7.0mbgl. Gas Work Waste were encountered in TP113 and TP121 with PID readings of 0.7ppm and 9ppm.

Potentially ACMs were recorded at TP111 and TP113, positioned centrally in the Site and adjacent to each other suggesting the asbestos are potentially confined to a localised area only.

There are considered to be a number of different areas of contamination recorded at the Site, considering the initial assessment of the laboratory results.

Diesel Contamination at Depth

Visual and olfactory evidence of contamination was recorded in BH102, BH103, BH104 and BH105 associated with the inflow of groundwater caught at the base of the Made Ground and surface of the Glacial Till. The laboratory data confirms that the shallower soils are not impacted with hydrocarbon contamination, however, the soils in contact with the groundwater, recorded elevated PID readings and elevated contamination concentrations.

The significantly elevated contaminants comprise TPH, benzene, PAHs including naphthalene, trimethylbenzenes and phenols. The TPH interpretations report the contamination comprises 'coal tar PAHs, degraded diesel and possible naturally occurring compounds'. This interpretation is consistent with the former uses of the Site as a mechanics garage and as part of a former gas works.

The number of exploratory hole locations at the Site was extensive and no obvious soil source of TPH (diesel contamination) was recorded. No underground or overground fuel storage tanks were noted at the Site at the time of the ground investigation. Due to the absence of a soil source, it is considered likely that the contamination at depth has resulted from poor site housekeeping practices and damaged drainage, although a soil source cannot be ruled out with certainty.

Benzene, naphthalene, trimethylbenzenes and phenol are volatile contaminants and present a risk through the vapour inhalation pathways. The location of the contamination together with the depth at which the contamination is recorded indicates removal of hotspots would likely be unfeasible and the proposed basement excavation will not extend deep enough to remove this material. The presence of these

contaminants is considered to pose an unacceptable risk to the proposed end-user and remediation measures will be required. It is recommended that suitable vapour membranes are incorporated into the foundation design of the proposed buildings and structures.

Gas Works Waste

Significantly elevated concentrations of cyanide, TPH, PAHs, arsenic, lead and mercury were recorded at trial pit TP113 and also similar observations were recorded at TP121. In addition, significantly elevated concentrations of naphthalene were recorded at the adjacent trial pit, TP109. This area of the Site is considered to be a hotspot of gas works waste. Exploratory holes were excavated to the east, south and west of this location and visual observations of gas works waste were not recorded, which is confirmed with the laboratory testing.

Trial pits TP113 and TP121 were positioned in the location of a former tunnel, which was found to be backfilled, as concluded from the buried structures noted in the trial pits. This is considered to be an isolated location on the Site and should be treated as a hotspot.

Metals and PAHs

Concentrations of low volatility metals and PAHs were recorded at a number of locations across the Site. The proposed end-use of the Site will comprise building footprints, hardstanding or soft landscaping areas. A potential risk from direct contact will exist at the Site and a suitable engineered cover system will be necessary in all areas of soft landscaping, and garden areas, to suitably manage the risk from low volatility contaminants.

Naphthalene

Significantly elevated concentrations of naphthalene were recorded across the Site in the hotspot areas indicated above, together with hand dug put HDP102.

Asbestos Fibres

Made Ground soils were subject to an asbestos screen to determine the presence of asbestos fibres. Asbestos fibres were recorded in a number of locations TP104, TP111, TP113 and TP114 at a depths of approximately of 1.0m bgl, A deeper depth, 6.50m at BH103 ACM was encountered. Visual signs of asbestos were recorded in 2No. trial pits (TP111 and TP113), which were abandoned due to the presence of a significant quantity of asbestos tiles.

3. Controlled Water Receptors

3.1 Surface Waters

There are no surface waterways present on site. The River Irk is located 193m to the north-west of the Site. It is considered the pathways to the River Irk are likely to be limited based on the low permeability Clay deposits.

3.2 Groundwater

The Glacial Till (Boulder Clay) underlying the Site is classified as Unproductive. The solid geology is designated as a Principal Aquifer.

Where the Glacial Till has been excavated at the Site, groundwater is encountered within the Made Ground contained above the Glacial Till surface. The groundwater level is dictated by the depth to the surface of the Glacial Till. The groundwater is likely to be perched and discontinuous across the Site, as evidenced by dry boreholes recorded at BH101 and BH104. Groundwater levels recorded during the post works monitoring indicates the groundwater will migrate locally to the north-east from BH105 towards BH102.

Ground Investigation has found that the Glacial Till Deposits comprises clayey soils with limited sand bands and no presence of groundwater. The Glacial Till provides a significant low permeability layer between the contaminated ground water and the underlying Principal Aquifer.

3.2.1 Sandstone – Chester Formation

The underlying sandstone bedrock associated with the Chester Formation is designated as a Principal Aquifer.

The underlying Sandstone was recorded from a depth of between 21.50 and - 22.30 (17m on the adjacent third-party site) at the Site.

Groundwater strikes were not recorded during the drilling works and the wells were found to be dry during the post works monitoring to date.

The significant thickness of Boulder Clay recorded at the Site indicates that in its current form a low risk of vertical migration is present. However, foundation piling could introduce a preferential pathway vertically between the perched water above the Boulder Clay and the underlying aquifer.

4. Foundation Proposals

The ground conditions recorded at the Site have indicated that the increased loadings from the apartment blocks are expected to exert, it is considered that piled foundations will be required.

The foundation solution for the residential towers, based on the site investigation information, are proposed as end bearing piles which would key into the sandstone bedrock between approximately 21m and 26m bgl. In addition, the proposed three storey buildings will also require piled foundations due to the depth of Made Ground recorded across the site. It is anticipated that underlying Boulder Clay will have sufficient bearing capacity to support the smaller structures utilising skin friction piles.

The Site is in a location with regards to controlled waters with the Chester Sandstone Formation classified as a Principal Aquifer. The risk of contaminant migration to the Principal Sandstone Aquifer and in turn the potable groundwater abstraction boreholes is therefore a possible risk which needs to be mitigated by the piling methodology proposed.

The Continuous Flight Auger (CFA) piling methodology is commonly used on developments where gross contamination is present and a risk to controlled waters exist. This is due to CFA piles being non-displacement, preventing void formation and thereby preventing the creation of preferential pathways during and post installation. The action of injecting the concrete as the auger is withdrawn creates a close seal at the interface between the pile and surrounding ground. In addition, the EA Land Centre Report 2001 NC/99/73 identifies CFA piles as the preferred means of foundation on contaminated sites, as they pose the least risk of groundwater pollution. CFA foundation piling has been successfully implemented at the Meridian Water One former gasworks, where widespread shallow ground and groundwater contamination was identified.

Given the above, CFA piles have been identified as the appropriate piling technique for foundation piles and will be assessed as part of this FWRA.

4.1 CFA Piling Methodology

The CFA piling methodology will be detailed in a Detailed Piling Method Statement produced separately by the piling contractor but will generally comprise the following activities, as described in the EA 2001 guidance.

A hollow stemmed CFA is used to excavate the pile bore and the bore filled with cement or grout. The auger is introduced into the ground by rotary methods at a speed and pitch that minimises soil displacement. The soil retained on the auger flights supports the bore sides. On achieving the required depth cementitious grout or plastic concrete is introduced under pressure via the hollow stem into the borehole base. The auger is withdrawn at a controlled rate whilst maintaining the concrete/grout at a positive pressure. Spoil is withdrawn from the hole on the auger flights and the concrete fills the hole under the auger head, the positive pressure is maintained forcing it into contact with the surrounding soil.

The plastic concrete in the borehole is maintained at a positive hydrostatic pressure that supports the borehole during the time taken for the concrete to cure. Once the complete auger string has been removed and the spoil arisings cleared away a reinforcing cage can if required be introduced into the plastic concrete in the pile assisted by vibration.

5. Piling impacts on Receptors

In the 2001 EA Land Centre Report NC/99/73 the following six potential source-pathway-receptor linkages are identified;

- **Pollution Scenario 1** - The creation of preferential flow paths allowing contaminated groundwater and leachates to move downwards through aquitard layers into underlying groundwater or between permeable horizons in a multi-layered aquifer;
- **Pollution Scenario 2** - The breaching of impermeable covers by piling or penetrative ground improvement, allowing ground gas or vapour infiltration from contaminated ground upwards;
- **Pollution Scenario 3** - Contaminated arisings being brought to the surface by piling work, with the risks of subsequent exposure to site workers and residents, and the need for appropriate handling;
- **Pollution Scenario 4** - The effects of aggressive ground conditions on materials used in piles;
- **Pollution Scenario 5** - Driving contaminated material downwards into an aquifer during construction/installation; and
- **Pollution Scenario 6** - Concrete or grout contamination of groundwater and any nearby surface waters.

Section 5 sets out a site-specific risk assessment of the proposed CFA piling methodologies pose to the environment as identified in the above six pollution scenarios.

5.1 Pollution Scenario 1 – Creation of a Preferential Pathway

Source

The ground investigation identified soil and groundwater contamination in the Made Ground, consistent with typical conditions at a brownfield site with a history of industrial land use. There is no evidence of the vertical migration of contaminants from the superficial deposits to have previously occurred.

The concentrations of TPH are greater off-site than on the subject site, therefore it is considered migration to the north is not significant from the subject Site. The off-site borehole is outside of the scope of this ground investigation.

Pathway

The creation of a preferential pathway along the pile sides and at the pile/soil interface during and post construction, and where the pile is permeable.

Receptor

The Glacial Till Deposits currently separates the Made Ground the sensitive underlying aquifer. The piles will penetrate the Glacial Till Deposits potentially creating a preferential pathway to Chester Sandstone Formation (Principal Aquifer).

Assessment

Piles founded in the Chester Sandstone Formation will result in the Glacial Till Deposits being breached and potential for preferential pathway to be formed between the Made Ground and the aquifer in the

Chester Sandstone Formation. The risk of a preferential pathway will be mitigated through using CFA piles.

The CFA piling methodology allows for the injection of concrete directly against the surrounding soil as the auger is slowly removed. A positive head is applied to the concrete to ensure the bore is supported and avoid ingress of soil and water into the concrete. This results in concrete forming a close seal against the material preventing a preferential groundwater pathway at the pile soil interface during and post completion. Also, the pile concrete has a lower permeability than the surrounding soils preventing the pile itself acting as a preferential flow path.

Residual Risk

The CFA pile is a non-displacement pile type. As identified in the 2001 EA guidance, where the bore is supported, there is a negligible risk of creating preferential pathways using this pile type.

To quantitatively demonstrate and confirm the piling works are not having an impact on deep groundwater in the Chester Sandstone Formation Principal Aquifer., a regime of long-term groundwater monitoring will be undertaken including sampling before, during and on completion of piling works.

5.2 Pollution Scenario 2 – Ground Gas and Vapours

Source

2No. ground gas monitoring rounds have been completed to date, with 6No rounds currently programmed and the ground gas monitoring period remains ongoing. Based on the ground gas monitoring completed to date the Qhg (borehole hazardous gas flow rate) has been determined for each borehole monitored. Assessment of the results records a maximum Qhg of 0.0027l/hr (CO₂). Based solely on the Qhg the ground gas regime would be classified as Characteristic Situation 1 (CS1) – Very low risk in which ground gas protection measures.

The PID readings indicated elevated volatile contaminants may be present at the Site at a number of locations. Representative soil samples were subject to laboratory testing to further characterise the site soils. The elevated PID readings are likely to be attributed to the presence of naphthalene and benzene, recorded at number of locations as discussed in the previous section.

A vapour risk is considered to exist at the site within regard to the Site soils.

Pathway

The creation of an upward preferential pathway through a surface layer, leading to ground gas and/or vapour migration to surface receptors.

Receptor

Confined spaces on-Site during construction.

Post development completion confined spaces will be absent.

Assessment

The rotary methodology of CFA piles limits the lateral extent of disturbed soil at the soil/pile interface, and

the concrete will have a lower permeability than the surrounding soil. The act of pumping the concrete under pressure as the auger is withdrawn also forms a close seal at the pile chalk interface. Preferential pathways for the migration of residual ground gases and vapours will therefore not be present post pile completion.

During construction safe working practices and Personal Protective Equipment (PPE) commensurate with the ground conditions and ground gas and vapour regime will be employed. These actions will mitigate the risk from ground gases and vapours.

Residual Risk

Given the absence of a significant ground gas lack of areas susceptible to ground gas and lack of preferential pathways post pile installation, a residual risk from ground gases to the development will not be present. Although a vapour risk is considered to exist. The vapour risk will be mitigated against through the use of vapour membranes in the final development, as detailed in the Remediation Strategy.

5.3 Pollution Scenario 3 – Contaminated Arisings

Source

A significant thickness of Made Ground was recorded at the Site up to depths of 7.80m below ground level (bgl). Glacial Till (Boulder Clay) was recorded underlying Made Ground between 13.0 and 19.2m in thickness. Bedrock comprising Chester Sandstone Formation was recorded between 15m and 26m m bgl.

Significantly elevated concentrations of PAHs, TPH, metals, cyanide and VOCs were recorded across the Site. Suspected Asbestos tiles were recorded at two locations and asbestos fibres were also recorded in the Made Ground at 5No. locations.

The underlying natural strata are generally uncontaminated.

Pathway

Direct contact with the pile arisings.

Entrainment of contaminants including dust and asbestos fibres by wind which migrate off-site and are potentially inhaled or ingested by off-site human health receptors.

Receptor

Construction workers, and off-site residents.

Assessment

Arisings from the CFA piles are produced as the auger is withdrawn, to mitigate the risk to construction workers and the migration of contaminants off-site the following measures will be undertaken;

- Damping down will be undertaken during construction of the capping beam and the removal of the auger to suppress any dust and fibres present and restrict their release into the environment;
- Construction workers will wear Personal Protection Equipment (PPE) suitable for the contaminant concentrations recorded on-Site; and

- Construction workers will be asbestos-aware.

During the removal of the augers, if gross evidence of contamination such as large caches of asbestos containing materials (ACM), visual or olfactory evidence of contamination, or other unforeseen contamination is encountered works shall be immediately stopped and an appropriate method statement prepared. The method statement will detail how the risk from the contamination will be mitigated and how works will continue without undue risk to the environment or receptors.

All arisings will be disposed of off-site and will therefore be classified in accordance with Waste Classification Technical Guidance WM3: October 2021, Guidance on the Classification and Assessment of Waste (1st Edition V1.2GB). The stockpiling of soils shall be minimised as far as is practically possible. Where arisings are stockpiled prior to removal off-site they will be separated to avoid cross contamination and temporary road access provided for placement and loading. Stockpiles will be positioned on impervious surfaces to collect drainage and prevent loss of entrenched water and leachate to ground.

Mitigation measures will be implemented to minimise wind whip from stockpiled materials. The Contractor will determine the appropriate methods for handling and the storage of materials, although these are likely to comprise damping down and covering of stockpiles. The details of the mitigation measures employed will be set out in a Construction Environmental Management Plan (CEMP) produced by the contractor.

Residual Risk

The application of PPE for construction workers, and mitigation measures to limit the release of contaminants into the environment would remove any residual risks.

5.4 Pollution Scenario 4 – Aggressive Ground Conditions

Source

Potential for aggressive ground conditions, with risks of degradation to installed foundation piles by chemical attack.

Pathway

Post installation the concrete piles will be in direct contact with the aggressive ground conditions in the underlying geology.

Receptor

Concrete piles and other below ground concrete structures.

Mitigation

For deep foundation design purposes, it is recommended using concrete mixes with a design class of DS Class DC-3, ACEC Class AC-3.

Piles and below ground structures will be formed from concrete which meets this specification and using the methodology in accordance with BRE SD1 (2005).

Residual Risk

The correct concrete specification would remove any residual risks.

5.5 Pollution Scenario 5 – Driving of Contamination Downwards

Source

Shallow soils contamination is identified in areas of the Site where piling is due to occur. Therefore, there is a risk that piling works could drive ground contamination downwards, creating a pathway to the r in the Glacial Till Deposits

Pathway

The driving of soil from the Made Ground vertically downwards along the pile toe or sides.

Receptor

Glacial Till deposits.

Assessment

CFA piling is a non-displacement methodology by which the material is extracted as the auger is progressed downwards. The driving down of contaminants along the pile sides and toe will therefore not occur.

Residual Risk

The CFA piling methodology will not drive materials downwards during its progression a residual risk to the Secondary A Aquifer is absent.

5.6 Pollution Scenario 6 – Concrete Entering the Groundwater

Source

Concrete injected through the hollow stem in the CFA auger following its withdrawal. Dependent on the final mix design the concrete will cure over 6 – 8 hours, identifying the period of contact with the wet cement as relatively short.

Pathway

Migration of concrete into underlying aquifers following progression below the water table is unlikely due to the Glacial Till Deposit is considered as a unproductive aquifer

Receptor

Glacial Till Deposits.

Assessment

The groundwater table in the Chester Sandstone Formation. The installed CFA piles will not extend below

the water table.

There is not risk to Principal Aquifer will be further mitigated through application of the following measures:

- The cement paste chosen for use within the piles will comprise a mix which will have a low water/cement ratio and have a suitable proportion of plasticisers to reduce water content within the concrete and limit segregation of the cement paste. The contaminants which make up the plasticisers will be confirmed prior to the use to ensure they do not in themselves provide a contamination risk to controlled water receptors outside of turbidity.
- The cement paste mix will be designed to have the quickest setting time whilst maintaining the structural requirements of the pile. This will reduce the time wet cement will have in contact with groundwater whilst it is mobile. Following the setting of the concrete it will be immobile removing the risk of concrete migrating from the pile.
- During injection of the cement paste the water and cement pressures will be closely monitored on a computer on the CFA piling rig to minimise concrete losses in all permeable horizons. Should the concrete volume exceed the theoretical value for the pile plus the standard overbreak the concrete pouring will cease, and an alternate methodology confirmed.

The concrete mix specification to be used, and the final methodology will be included in a detailed method statement produced by the piling contractor. The methodology and mix will aim to minimize concrete losses as far as is practically possible and reduce the concrete setting time whilst maintaining the pile.

Residual Impact

The application of a suitable concrete mix and monitoring of concrete injection and the concrete and water pressures during pile construction will ensure the migration of wet concrete will be restricted and any impact on the Glacial Till Deposits is likely to be highly localised and unlikely to impact the potable groundwater abstraction boreholes.

5.7 Piling Impact Summary

A summary of the proposed CFA piling impact on identified receptors, and the mitigation measures required during construction are detailed in Table 3.

Table 3: Summary of the Pollution Scenario Assessment

Pollution Scenario	Assessment	Impact	Mitigation Measures
Scenario 1 – Creation of preferential pathways	Geology on-Site generally comprises Made Ground underlain by Glacial Till Deposits and Chester Sandstone Formation bedrock. Foundation piles are anticipated to extend into the Chester Sandstone Formation and therefore have the potential to create a preferential pathway allowing contaminants to vertically migrate downwards. The CFA piling methodology have minimal lateral disturbance preventing the outside of the pile acting as a conduit for the vertical migration of contaminants. The piles will be concrete which has a lower permeability than the surrounding soil and will not form a preferential flow path. The action of pumping the concrete as the CFA auger is withdrawn forms a close seal at the pile Chester Sandstone Formation interface.	Low	Maintenance of a positive head of concrete during injection to avoid ingress of soil and water into the concrete.
Scenario 2 – Ground gas and vapours	Ground investigations have recorded the Made Ground has having a low ground gas vapour generation potential, with a maximum CS-1 classification being calculated for ground gas and elevated vapour concentrations recorded on Site. The CFA piling methodology limits the lateral extent of disturbed soil at the soil/pile interface, and the concrete will have a lower permeability than the surrounding soil. Therefore, preferential pathways for the migration of residual ground gases and vapours will not be present post pile completion.	Low	The ground gas regime is classified as between CS-1 (very low risk) across the Site. A significant vapour regime is present across the majority of the site. Mitigation measures are therefore limited to PPE/RPE for construction workers.
Scenario 3 – Contaminated Arisings	Metals, hydrocarbon, and asbestos contamination has been identified in Made Ground at the Site. During withdrawal of the CFA auger construction workers and surrounding off-site receptors could be exposed these contaminants. To mitigate the risk the material will be damped down, appropriate PPE worn, and stockpiles minimised, placed on impermeable surfaces to prevent the loss of entrenched water and leachate, and covered.	Low	Construction workers should wear the appropriate PPE and adhere to the Control of Asbestos Regulations 2012. Material excavated should be damped down to prevent wind entrainment of contaminants and asbestos fibres. Stockpiles minimised, placed on impermeable surfaces, and covered.
Scenario 4 –	Where the concrete is designed in accordance with the classifications identified in the	Low	Concrete designed to the correct

Pollution Scenario	Assessment	Impact	Mitigation Measures
Aggressive ground conditions	Waterman Geotechnical Design Report the piles will be protected from the aggressive ground conditions.		specification.
Scenario 5 – Driving of Contamination Downwards	The CFA piling is a non-displacement methodology by which the material is extracted as the auger is progressed downwards. The driving down of contaminants along the pile sides and toe will therefore not occur.	Low	N/A
Scenario 6 – Concrete entering groundwater.	The piles might extend into the groundwater table. To minimise concrete loss the cement mix specification used will have a low water cement ratio and have the shortest setting time whilst maintaining the pile structural requirements. Plasticisers will be used to further reduce the water cement ration and limit the segregation of the cement paste.	Low	Correct specification of the concrete mix set out in a detailed piling method statement produced by the piling contractor. Close monitoring during concrete injection to identify and prevent concrete loss over the theoretical pile volume including overbreak.

6. QA/QC Procedures

The Quality Assurance (QA) and Quality Control (QC) procedures to be followed by the piling contractor will include the following items;

- The pile concrete type and quality, and procedure for testing the quality;
- Pile load testing;
- Pile spoil handling, removal and disposal including how the spoil arisings will be stockpiled;
- Dust suppression and monitoring;
- The detailed pile installation methodology including the control of depth;
- Groundwater monitoring pre, during, and post piling completion.
- The prevention of surface water run-off from any stockpiled arisings.
- The QA/QC procedures will be set out in the following documents;
 - Detailed Piling Method Statement produced by the piling contractor; and
 - Construction Environmental Management Plan (CEMP), produced by the Contractor.

7. Methodology, Mitigation and Monitoring

7.1 Waste Management

A preliminary Waste Classification Assessment has been completed the Geo-Environmental Assessment for the Site (Report Ref: WIE19453-100-R-2.2.1-GeoEnv). The preliminary assessment highlighted samples from BH02 and BH03 as hazardous and under the European Waste Catalogue, classified as EMC Code - 17 05 03* described as '*Soils and stones containing hazardous substances*'.

The proposed CFA piling method will generate soil arisings from both the Made Ground and underlying Glacial Till together with the sandstone stratum. It is recommended that should soil arisings need to be disposed of off-site, suitable testing of the soils is completed and a Waste Classification Assessment is completed.

Where materials are proposed for re-use then this will be undertaken in accordance with the CL:AIRE Definition of Waste: Code of Practice (DoWCoP), subject to appropriate sampling and testing, risk assessment and compliance with the requirement of the DoWCoP.

7.3 Noise and Vibration

A Method Statement, covering noise and vibration, will be prepared by the specialist piling contractor. Noise levels are expected at times to be moderate. Appropriate PPE should be worn by site personnel

7.4 Monitoring for Unforeseen Contamination

The pile arisings should be inspected and monitored for previously unknown / unforeseen contamination. Should visual or olfactory evidence of contamination be observed, a Waterman Environmental Engineer should attend site and advise on an appropriate course of action.

8. FWRA Conclusions and Recommendations

A Foundation Works Risk Assessment in accordance with the EA's publication *Piling and penetrative ground improvement methods of land affected by contamination: Guidance on pollution prevention* (NGWCLC Report NC/99/73)' has been undertaken and the relevant pollution scenarios assessed.

It is proposed to install piled foundations at the Site, which will penetrate through the Made Ground and Glacial Till into the underlying sandstone bedrock (Chester Formation). Piles will be keyed into the Chester Formation and formed using non-displacement continuous flight auger techniques.

The ground investigation identified the presence of contamination within the Made Ground and water collected above the surface of the Glacial Till. The potential for these contaminants to migrate into the underlying aquifer following the construction of piles is considered to be Low.

The assessment identified that the construction of the piles and the likelihood of potentially adverse impacts resulting from the proposed piling activities is considered to be Low, provided that works are carried out in accordance with appropriate Risk Assessments and Method Statements.

The ground conditions reported relate only to the point of excavations during the ground investigation (October 2022) and do not necessarily guarantee a continuation of the ground conditions throughout the non-inspected area of the Site. Whilst such exploratory holes would usually provide a reasonable indication as to the general ground conditions, these cannot be determined with complete certainty.

In conclusion, the proposed piles are considered suitable for the proposed development at the Site and it has been demonstrated that there is no resultant unacceptable risk to the groundwater

8.1 Piling Method and Control Measures

The CFA piling methodology owing to its suitability in scenarios in which a risk of groundwater pollution is present has been brought forward for assessment against the six pollution scenarios identified by the EA.

Assessment of the CFA piling methodology against the six pollution scenarios identified a low residual risk to the surrounding environment, where the appropriate mitigation measures are followed, which include;

- Maintenance of a positive head of concrete pressure as the auger is removed from the bore is supported, and the ingress of soil and groundwater is avoided;
- Construction workers should wear the appropriate PPE/RPE and across the Site and wider surround adhere to the requirements of the Control of Asbestos Regulations 2012 and the Confined Space Regulations.
- Material arising from the auger should be dampened down.
- Stockpiles should be minimised wherever possible, covered, and placed on impermeable surfaces to prevent the loss of entrenched water and leachate.
- The concrete shall meet the classifications as recorded during the ground investigations.
- The cement specification will be set out in a detailed method statement produced by the piling contractor but will prioritise a low water: cement ratio and fast setting time to minimise contact of the wet cement with groundwater in the Chester Sandstone Formation. Plasticisers will be used as appropriate to further reduce the water: cement ratio and limit the segregation of cement paste.

- The volume of concrete used for each pile will be closely monitored against the theoretical volume plus overbreak to ensure excess concrete is not injected. To demonstrate and confirm the Site is not having an impact on the sensitive controlled water receptors, groundwater monitoring for the identified groundwater contaminants of concern and turbidity will be undertaken prior to during and post piling works completion.



APPENDICES

A. Site Plans

- A1 Proposed Site Plan (General Arrangements)
- A2 Soil Exceedances with Proposed Building Footprint
- A3 Groundwater Exceedance Plan

Appendices

Foundation Works Risk Assessment
Document Reference:
WIE19453-100-R-4-1-2-FWRA

This drawing should not be scaled. Dimensions to be verified on site.
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GENERAL NOTES

- SITE BOUNDARY
- ✱ WS101 WINDOW SAMPLE LOCATIONS
- ✱ BH101 15-20M CABLE PERCUSSIVE BOREHOLES WITH FOLLOW ON 10M ROTARY CORING
- ✱ TP111 TRIAL PITS TO ESTABLISH EXISTING FOUNDATION ARRANGEMENTS
- ✱ HDP101 HAND DUG PIT LOCATIONS (POSITIONED ON SITE, NOT SURVEYED)
- ▨ EXPLORATORY HOLE LOCATIONS WITHIN BUILDING WERE POSITIONED ONSITE, NOT SURVEYED
- SOIL EXCEEDANCES

TP113 @ 1.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Arsenic	40	79.9
Lead	310	3919
Mercury	1.2	13.4
Cyanide (free)	26	240.7
TPH Aromatic EC21-EC35	-	2952
Naphthalene	2.3	2.74
Benzo(b)fluoranthene	3.9	4.48
Dibenzo(ah)anthracene	0.31	0.55

TP109 @ 2.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Naphthalene	2.3	46.64
Benzo(a)anthracene	11	61.43
Benzo(b)fluoranthene	3.9	67.94
Benzo(a)pyrene	3.2	66.84
Dibenzo(ah)anthracene	0.31	10.97

HDP102 @ 0.6m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Naphthalene	2.3	4.141
Benzo(a)pyrene	3.2	6.347
Dibenzo(ah)anthracene	0.31	0.96

BH102 @ 3.8m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Benzo(b)fluoranthene	3.9	5.69
Benzo(a)pyrene	3.2	5.39
Dibenzo(ah)anthracene	0.31	0.78

BH102 @ 5.8m		
TPH Aromatic EC10-EC12	250	352
TPH Aromatic EC16-EC21	1900	6172
TPH Aromatic EC21-EC35	-	7296
Naphthalene	2.3	188.91
Benzo(a)anthracene	11	116.61
Chrysene	30	135.54
Benzo(b)fluoranthene	3.9	115.59
Benzo(a)pyrene	3.2	113.39
Dibenzo(ah)anthracene	0.31	16.7
1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene*	0.41	4.24
1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene*	0.41	0.63

BH102 @ 8.50m		
Naphthalene	2.3	8.5

BH103 @ 5.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Naphthalene	2.3	26.03
Benzo(a)anthracene	11	15
Benzo(b)fluoranthene	3.9	14.44
Benzo(a)pyrene	3.2	12.09
Dibenzo(ah)anthracene	0.31	2.4

BH103 @ 6.5m		
TPH Aromatic EC10-EC12	250	347.9
TPH Aromatic EC16-EC21	1900	2358
TPH Aromatic EC21-EC35	-	3047
Benzene	0.38	4.58
Naphthalene	2.3	323.1
Benzo(a)anthracene	11	28
Benzo(b)fluoranthene	3.9	30.59
Benzo(a)pyrene	3.2	24.59
Dibenzo(ah)anthracene	0.31	4.63
4-Methylphenol & 2,4-Trimethylphenol*	3.9	31.33
4-Methylphenol & 2,4-Trimethylphenol*	3.9	63.33
1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene*	0.41	41.28
1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene*	0.41	8.76

BH101 @ 0.5m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Dibenzo(ah)anthracene	0.31	1.55

TP108 @ 4.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Lead	310	395

TP114 @ 1.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Lead	310	360

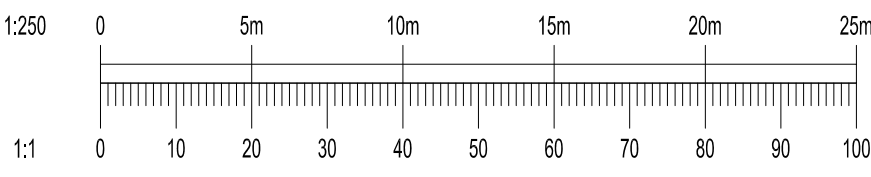
BH105 @ 7.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Chrysene	30	929
Benzo(b)fluoranthene	3.9	6.543

TP102 @ 2.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Lead	310	474
Dibenzo(ah)anthracene	0.31	0.44

TP115 @ 2.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Lead	310	721
Benzo(b)fluoranthene	3.9	5.35
Benzo(a)pyrene	3.2	4.43
Dibenzo(ah)anthracene	0.31	0.76

BH104 @ 1.0m		
Contaminant	Threshold Value (mg/kg)	Concentration (mg/kg)
Naphthalene	2.3	19.67
Benzo(a)anthracene	11	12.64
Benzo(b)fluoranthene	3.9	11
Benzo(a)pyrene	3.2	10.09
Dibenzo(ah)anthracene	0.31	1.7

BH104 @ 5.0m		
Naphthalene	2.3	18.27
Dibenzo(ah)anthracene	0.31	0.41



P01	S0	22.11.22	AS BUILT ISSUE	DC	RT
Status	Date	Description	By	Chk	

Amendments	
Project	ROCHDALE ROAD
Title	SOIL EXCEEDANCE PLAN
Client	

	
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Status	AS BUILT
Designed By	RT Director Waterman Ref WIE19453-100
Drawn By	DC Date NOVEMBER 2022 Scales @ A1 1:250
Project - Originator - Volume - Level - Type - Role - Number Revision	
19453-100-WIE-ZZ-XX-DR-V-80-004 P01	

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-  EXPLORATORY HOLE LOCATIONS WITHIN BUILDING WERE POSITIONED ONSITE, NOT SURVEYED
-  GROUNDWATER EXCEEDANCES

BH105		
Contaminant	Threshold Value (µg/l)	Max. Concentration (µg/l)
Nickel	4	8
2,4-Dimethylphenol	7.7	95
Naphthalene	2	62
2-Methylnaphthalene	2	25
TPH Aromatic EC10-EC12	N/A	245
TPH Aromatic EC12-EC16	N/A	580
TPH Aromatic EC16-EC21	N/A	410
TPH Aromatic EC21-EC35	N/A	480

BH103		
Contaminant	Threshold Value (µg/l)	Max. Concentration (µg/l)
Nickel	4	9
TPH Aromatic EC12-EC16	N/A	110
TPH Aromatic EC16-EC21	N/A	340
TPH Aromatic EC21-EC35	N/A	480

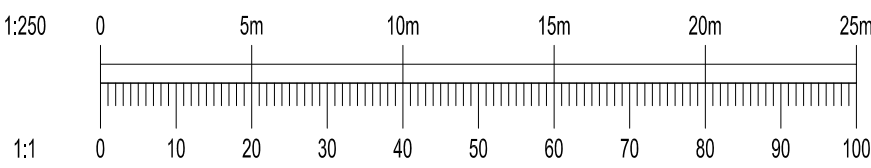
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Status	Date	Description	By	Chk

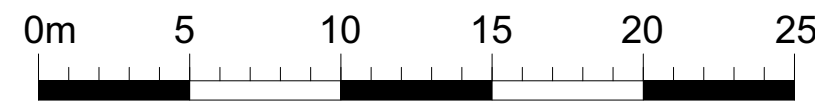
Amendments	
Project	ROCHDALE ROAD
Title	GROUNDWATER EXCEEDANCE PLAN
Client	



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Status		AS BUILT	
Designed By	RT	Director	RT
Drawn By	DC	Date	NOVEMBER 2022
Project - Originator - Volume - Level - Type - Role - Number		Revisions	
19453-100-WIE-ZZ-XX-DR-V-80-006		P01	

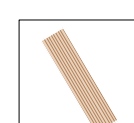
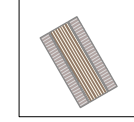
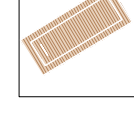
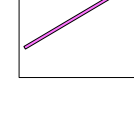
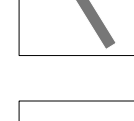
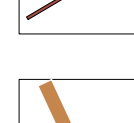
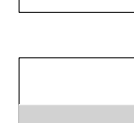
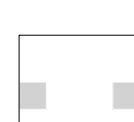
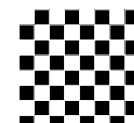
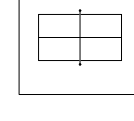
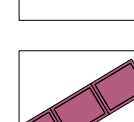
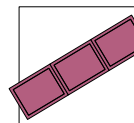




Key

- **Mulbury Planning Application Boundary**
- **HARDWORKS**
Natural Stone Paving Mix 1
To public realm & shared community space
Type: Portuguese granite
Colour: TBC
Finish: TBC
Supplier: Hardscape or similar approved
Note: allow for galvanised 3x150mm exccell edge
- **Clay Paving Mix 2**
To match adjacent MCR site (H3 material) pedestrian areas throughout the site.
Type: Clay Paving
Colour: Various to complement architectural material palette
Finish: TBC
Supplier: Hardscape or similar approved
Note: allow for galvanised 3x150mm exccell edge
- **Clay Paving Mix 3**
To private garden space
Type: Neland Clay Paving
Colour: TBC
Finish: TBC
Supplier: Hardscape or similar approved
Note: allow for galvanised 3x150mm exccell edge
- **Green gap concrete paving**
To Residential spaces
Type: Concrete
Colour: TBC
Finish: TBC
Supplier: Hardscape or similar approved
Note: allow for galvanised 3x150mm exccell edge
- **Granite Planks**
To Residential spaces
Type: Portuguese granite
Colour: TBC
Finish: TBC
Supplier: Hardscape or similar approved
- **Natural Stone Paving**
Type: Yorkstone
To match approved MCR site Gould street highway paving
Size, colour finish, to MCC standard detail
Note: allow for 125x255mm kerb edge

FURNITURE & STRUCTURES

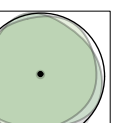
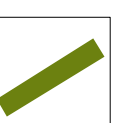
- **Seating Edge**
To Courtyards
Timber top corten frame
- **Picnic Table**
Timber top picnic table with powdercoated galvanised frame
- **Tiered Seating Feature**
Timber seating with integrated tree, details tbc
- **1.8m Rimini Galvanised Steel Fence**
details tbc
- **Retaining Structure**
Existing To Gould street & 87 Rochdale Road
- **1.1m Rimini Galvanised Steel Balustrade**
To private spaces, details tbc
- **Timber play feature**
To community shared spaces, details tbc
- **Proposed 1.1m wall with 500mm railing**
Brickwork finish to match building facade
- **1.5m Pillar Wall**
To courtyard edge
details tbc
- **Chess Board - Play**
To courtyard edge
- **Table tennis**
To courtyard edge
- **Planting Screen**
2.5m high Galvanised steel planting screen to courtyard
finish: tbc
- **Cycle Stands**
10no. Sheffield cycle stands to external spaces
- **Bin Store**
Controlled accessed 3 No. 1100L & 1no.240L bins to town house & duplex's

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- NOTES:
- Do not scale from this drawing.
 - Always work to noted dimensions.
 - All dimensions are in millimetres unless otherwise stated.
 - All setting out, levels and dimensions to be agreed on site.
 - The dimensions of all materials must be checked on site before being laid out.
 - This drawing must be read with the relevant specification clauses and detail drawings.
 - Order of construction and setting out to be agreed on site.

NOTE:
General Arrangement drawing to be read in conjunction with drawings:
2624-PLA-XX-XX-DR-L-1001
2624-PLA-XX-XX-DR-L-1002
2624-PLA-XX-XX-DR-L-2000
2624-PLA-XX-XX-DR-L-3000

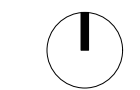
SOFTWORKS

- **Trees**
A combination of single & multi-stem trees. Refer to drawing 2426-PLA-XX-XX-DR-L-2000 for specification.
- **Clipped Instant Hedge**
To private garden boundaries
Size: 800mmW x 1200mmH approx.
Refer to drawing 2426-PLA-XX-XX-DR-L-2000 for specification.
- **Ornamental Shrub and Herbaceous Planting**
Biodiversity rich planting.Refer to drawing 2426-PLA-XX-XX-DR-L-2000 for specification.
- **Marginal Ornamental Planting**
To swales / rain gardens Refer to drawing 2426-PLA-XX-XX-DR-L-2000 for specification.
- **Lawn**
Medallion turf
Supplier: Rolawn or similar approved
- **Planting Bed**
450mm high timber planter, planting to residential community choice

S1-P06	06-12-21	Bin storage and boundary update	AS	KR
S1-P05	11-11-21	Updated boundary	AS	KR
S1-P04	01-09-21	Planning Issue	AS	KR
S1-P03	02-08-21	Draft Planning	AS	KR
S1-P02	20-07-21	For information	AS	KR
S1-P01	27-05-21	For coordination	AS	KR

Revision	Date	Description	Drawn	Apprvd.
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T: 0207 253 5678
STANDISH
Standish Gatehouse, Stonehouse, Gloucestershire, GL10 3BZ
T: 0145 360 7080

Client **Portwood Development Ltd**

Project **87 Rochdale Road**

Drg Title **General Arrangement**

Created on	Created by	Approved by
02.08.21	AS	KR

Scale	Size	Workstage
1:250	A1	RIBA Stage 2

Drg No.	Suitability	Revision
2624-PLA-XX-XX-DR-L-0002	S1	P06

UK and Ireland Office Locations

