



Foundation Works Risk Assessment

Rochdale Sixth Form College, Rochdale

November 2023

Waterman Infrastructure & Environment Limited

6th Floor, Trinity Court, John Dalton Street, Manchester, M2 6HY
www.watermangroup.com



Client Name: Waterman Structures Limited
Document Reference: WIE19085-100-R-5-1-3-FWRA
Project Number: WIE19085

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
First	November 2023	Ugne Ankenaite Consultant  Andrew Mould Principal Consultant 	Paul Latta Principal Consultant	Rachael Tempest Associate Director 

Comments

Disclaimer

This report has been prepared by Waterman Infrastructure & Environment Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.

Contents

Foundation Works Risk Assessment
Document Reference: WIE19085
WIE19085-100-R-5-1-3-FWRA

Contents

1. Introduction	1
1.1 Objectives	1
1.2 Proposed Development	1
1.3 Planning Context.....	1
1.4 Previous Reports.....	1
2. Environmental Site Setting	3
2.1 Geology and Hydrogeology	3
2.2 Contamination Sources.....	4
3. Controlled Water Receptors	6
3.1 Surface Waters	6
3.2 Groundwater	6
3.2.1 Alluvium.....	6
3.2.2 Pennine Lower Coal Measures Formation.....	6
4. Foundation Proposals.....	7
4.1 Driven Piling Methodology	7
4.1.1 Pre-formed Hollow Piles	7
4.1.2 Pre-formed Solid Piles	7
5. Piling impacts on Receptors	9
5.1 Pollution Scenario 1 – Creation of a Preferential Pathway	9
5.2 Pollution Scenario 2 – Ground Gas and Vapours.....	10
5.3 Pollution Scenario 3 – Contaminated Arisings.....	11
5.4 Pollution Scenario 4 – Aggressive Ground Conditions	11
5.5 Pollution Scenario 5 – Driving of Contamination Downwards	12
5.6 Pollution Scenario 6 – Concrete Entering the Groundwater or Surface Water	13
5.7 Piling Impact Summary	13
6. QA/QC Procedures	16
7. Methodology, Mitigation and Monitoring	17
7.1 Waste Management.....	17
7.2 Noise and Vibration.....	17
7.3 Monitoring for Unforeseen Contamination	17
8. FWRA Conclusions and Recommendations	18
8.1 Piling Method and Control Measures.....	19

Contents

Tables

Table 1:	Previous Reports Relating to the Site	2
Table 2:	Site Geology and Hydrogeology	3
Table 3:	Summary of the Pollution Scenario Assessment	14

Appendices

- A. Site Plans

Contents

1. Introduction

1.1 Objectives

Waterman Structures Limited (WSL) instructed Waterman Infrastructure & Environment Limited (Waterman) to prepare a Foundation Works Risk Assessment (FWRA) for the proposed development at Rochdale Sixth Form College, Rochdale (hereafter referred to as “the Site”).

The purpose of the FWRA is to set out the potential impacts the proposed piling works might 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 Environment Agency (EA) guidance ‘Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention’, (2001, Ref. NC/99/73), and EA Booklet ‘Piling into Contaminated Sites’ (2002).

This report is informed by and should be read in conjunction with the previous reports listed in Section 1.4.

1.2 Proposed Development

The Site is currently in use as a car park and it is proposed to redevelop the Site for an educational end use comprising construction of a new six-storey extension to the existing Rochdale Sixth Form College. In addition to the proposed building construction, it is also understood that there will be alterations to external surfaces; however, no new areas of soft landscaping are proposed. A roof garden is to be provided on the sixth floor.

The consented development Drawings is included in Appendix A

1.3 Planning Context

The Scheme gained planning consent (Ref: 22/01441/PSID) by Rochdale Borough Council in 2023. Planning Condition 6 is relevant to deep foundations and states the following:

Condition 6: Piling

Piling using penetrative methods shall not be carried out other than with the prior written consent of the local planning authority. The development shall be carried out in accordance with the approved details.

Reason: To ensure that the proposed piling does not harm groundwater resources in line with the provisions of the National Planning Policy Framework

The information in this report has been prepared to support the discharge of Planning Condition 6 and should be submitted to the Rochdale Borough Council for approval.

1.4 Previous Reports

A number of previous reports have been prepared for the Site, 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
Preliminary Environmental Risk Assessment	Waterman	June 2022	WIE19085-105-R-1-1-3-PERA
Coal Mining Risk Assessment	Waterman	October 2022	WIE19085-100-R-5.1.3-CMRA
Generic Quantitative Risk Assessment	Waterman	July 2023	WIE19085-108-4-R-4.1.3-GQRA

2. Environmental Site Setting

This section provides an overview of the Site's environmental setting as identified by intrusive investigation completed at the Site in April 2023 by Waterman, as reported in the Generic Quantitative Risk Assessment.

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 (mbgl)
Surfacing (Tarmac, Paving Slabs, Concrete)	0.05 – 0.15	Not classified	N/A
Made Ground (sub-base)	0.15		N/A
Made Ground (Sand)	0.8 - 1.2		N/A – no continuous groundwater body across the Site identified.
Made Ground (gravel)	0.35 - 1.9		N/A – no continuous groundwater body across the Site identified. CP102S was observed to range between being dry and groundwater being present at 2.1m bgl.
Made Ground (Cohesive)	1.8		N/A – no continuous groundwater body across the Site identified.
Alluvium (Sand and Clay)	>1.6 – 7.4	Secondary A Aquifer	2.2m bgl – 5.0m bgl
Glacial Till (Clay)	1.9	Unproductive Strata	N/A – no groundwater was recorded within this stratum.
Pennine Lower Coal Measures Formation	>2.61	Secondary A Aquifer	Groundwater strike encountered in CP102 at 8.1mbgl

During the recent ground investigation, groundwater was encountered in both cable percussive boreholes (CP101 and CP102) between 3m bgl and 5m bgl within gravelly sand. Groundwater was encountered in all window sample locations (WS101-WS104) at depths of between 2.2mbgl and 3.0mbgl within clayey sand or sandy clay. It is considered this represents a groundwater body associated with the Alluvium.

A second groundwater strike was recorded in borehole CP102 within the mudstone at 8.1mbgl. It is considered a second water body associated with the Coal Measures is present at depth.

No visual or olfactory evidence of contamination was encountered during the ground investigation.

6No. groundwater level monitoring rounds were undertaken between April and June 2023 as part of the post fieldwork monitoring, indicating that groundwater is present within the sand layer of the underlying Alluvium and migrating locally to the north from CP101 towards CP102. The groundwater is noted to follow the flow direction of the adjacent canalised River Roch. The Alluvium is designated as a Secondary A Aquifer.

2.2 Contamination Sources

The 2023 Waterman GQRA highlights the potential for contamination to be present at the Site associated with the historical cotton and woollen mills and 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 programme of gas monitoring was also completed as part of post-site works monitoring.

During the investigation, no visual or olfactory evidence of contamination was noted within the soils. Soil samples were subject to screening using PID (Photo Ionization Detector), which generally recorded <1.0ppm within the Made Ground and zero within the natural soils with the highest readings of 1.3ppm recorded at 1.2mbgl in window sample WS102.

No suspected Asbestos Containing Materials (ACMs) were recorded during the ground investigation.

An initial assessment of the soil laboratory results against residential without plant uptake GAC did not identify any contaminant exceedances.

Vapours

Minor exceedances of mid-chain aliphatic carbon bands were recorded in the limited perched water within the Made Ground at one location (WS102) when compared to SoBRA VAPGW assessment criteria.

Based on the minor exceedance, the limited soil concentrations and lack of wider TPH concentrations in the soil and groundwater, together with the highly conservative assessment criteria, the risk from vapours from the groundwater is considered to be low based on the multiple lines of evidence.

Metals and PAHs

Concentrations of nickel and low volatility PAHs were recorded from one sample collected from the limited perched water body (WS102) within the Made Ground.

Concentrations of low volatility lead and iron were recorded in two groundwater samples from CP101 and CP102 with installations within the Alluvium Secondary A Aquifer. It is considered that the Alluvium soils could be a possible background source of iron.

Hydrocarbons

Elevated concentrations of TPH were recorded in the groundwater at WS102. Limited TPH was recorded in the site soils at the same carbon bands, and TPH was not recorded to be elevated in CP101 and CP102 with installations within the Alluvium Secondary A Aquifer indicating vertical migration is likely to be limited.

Asbestos Fibres

Made Ground soils were subject to an asbestos screen to determine the presence of asbestos fibres. Asbestos fibres were recorded in one Made Ground sample from WS101 at 0.8m bgl (Amosite fibre bundles). Asbestos quantification indicates a concentration of 0.001%.

3. Controlled Water Receptors

3.1 Surface Waters

There are no surface waterways present on site. The River Roch flows from south to north on the eastern boundary of the Site. It is considered the canalisation of the surface water will mean lateral migration of groundwater and contaminants into the river is likely to be restricted.

3.2 Groundwater

Both the Alluvium underlying the Site and the solid geology are classified as Secondary A Aquifers.

Groundwater is encountered within the Made Ground in two locations only (WS102 and WS103). The groundwater is likely to be perched and discontinuous across the Site, as evidenced by boreholes WS104 and WS102 being dry on the final monitoring round, indicating the volume of water is likely to be limited across the Site. It is likely, also, that the perched water is limited in its connectivity to the underlying Alluvium and River Roch.

3.2.1 Alluvium

Groundwater was encountered in all window sample locations at depths of between 2.2m bgl and 3.0m bgl within clayey sand or sandy clay Alluvium. It is considered that there is a continuous groundwater body associated with the Alluvium Secondary A Aquifer. Groundwater levels recorded during the post works monitoring indicate that the groundwater is migrating locally to the north from CP101 to CP102 within the sand layers in the Alluvium, roughly following the flow direction of the adjacent canalised River Roch.

3.2.2 Pennine Lower Coal Measures Formation

The underlying mudstone bedrock of the Pennine Lower Coal Measures Formation is designated as a Secondary A Aquifer.

The underlying Mudstone was recorded from a depth of between 8.10m and 11.3m bgl beneath the Site.

A groundwater strike was recorded in borehole CP102 within the mudstone at 8.1mbgl. This is considered to represent the groundwater table within the Pennine Lower Coal Measures bedrock aquifer.

A low to medium to low risk of vertical migration between the two aquifers is considered to be present. However, foundation piling could introduce a preferential pathway vertically between the limited perched water within the Made Ground and the underlying aquifer.

4. Foundation Proposals

On the basis of the ground conditions recorded at the Site and the loadings which the proposed extension is expected to exert, it is considered that piled foundations will be required.

The foundation solution for the six-storey extension to the existing Rochdale Sixth Form College, based on the ground investigation information, is proposed to be a driven piling system comprising 244mm driven tube piles into the Mudstone for a working load of 750kN. The piles would drive into the Mudstone by about 1.0m to 1.5m, therefore, are anticipated to extend to approximately 9.1m - 12m deep. This is consistent with the foundation solution for the existing Rochdale Sixth Form College building, which is adjacent to the extension.

The Site is underlain by a Secondary A Aquifer within the Alluvium and Pennine Lower Coal Measures. The risk of contaminant migration into the Secondary A Aquifers resulting in impact to the quality of both water bodies is therefore a possible risk which needs to be mitigated by the piling methodology proposed.

The River Roch is adjacent to the Site. It is considered the canalisation of the surface water will mean lateral migration of groundwater and contaminants into the river is likely to be restricted.

4.1 Driven Piling Methodology

The driven 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.

Driven piling is a displacement method that does not result in arisings being generated at the surface.

Driven piles can either being formed by using pre-fabricated piles driven directly into the ground, or by driving a casing into the ground and filling the hole so created with concrete.

4.1.1 Pre-formed Hollow Piles

Pre-formed hollow piles consist of cylindrical steel or concrete elements that are driven into the ground to the required depth and are subsequently filled with concrete or cementitious grout. The cylindrical elements may be prepared to the required length or may be made up of a number of jointed elements. Some systems involve the driving loads being applied to the top of the cylindrical elements, whilst others apply the driving force directly to a shoe at the base of the cylindrical column.

Hollow concrete piles are formed from tubular sections and are sometimes described as cylinder piles. The concrete used to infill the piles can be reinforced or post tensioned, therefore having good resistance to bending forces or tension.

4.1.2 Pre-formed Solid Piles

Solid concrete piles can be either pre-cast reinforced or pre-stressed concrete. These may be pre-cast to the correct driving length or may be made up of a number of jointed segments

Segmental piles may be formed in a variety of sections (square, hexagonal, circular) and have the advantages of standardised manufacturing length, ease of transport and reduction of stress on the pile during handling. The segments are held together during driving by proprietary jointing systems, ranging

from simple male-female socketed joints to more complex systems that prevent rotation of segments relative to each other. Once installed and carrying their service load the compressive forces in the pile will ensure that the joints remain tight.

Pre-cast concrete piles may be reinforced or pre-stressed and can be installed at sub vertical angles and to depths greater than 50m. High cement concrete mixes are used and concrete cover is at a minimum thickness over reinforcing to reduce the risk of spalling. Each section incorporates a steel jointing piece at either end. The main benefit of pre-stressing concrete piles is that tensile stresses are reduced during driving, thereby minimising the chances of cracking the pile. However, a pre-stressed pile is more vulnerable if it hits an obstruction.

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 for the proposed driven piling methodology to assess the risk posed to the environment by the above six pollution scenarios.

5.1 Pollution Scenario 1 – Creation of a Preferential Pathway

Source

The ground investigation identified marginal soil and groundwater contamination in the Made Ground and marginal hydrocarbon contamination within the Alluvium Secondary A Aquifer, 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.

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

Cohesive layers in the Alluvium appear to currently separate the Made Ground and the underlying Pennine Lower Coal Measures aquifer. The piles will penetrate the Alluvium Deposits potentially creating a preferential pathway between the Made Ground and the Pennine Lower Coal Measures (Secondary A Aquifer).

Assessment

Piles founded in the Pennine Lower Coal Measures will result in the Alluvium Deposits being breached and potential for preferential pathway to be formed between the Made Ground and the aquifer in the Pennine Lower Coal Measures.

The soil surrounding the pile will be densified and high stresses induced in the surrounding ground when driving displacement piles. These stresses increase 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 contaminant concentrations recorded in the ground investigation indicate that the potential impact of preferential pathways would be low.

Residual Risk

To quantitatively demonstrate and confirm the piling works are not having an impact on the groundwater within the Pennine Lower Coal Measures Secondary A Aquifer a regime of 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

Ground gas monitoring programme of 6No. rounds have been completed at the Site. The Qhg (borehole hazardous gas flow rate) has been determined for each borehole monitored. Assessment of the results records a maximum Qhg of 0.0005l/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 are not required.

The PID readings generally recorded <1.0ppm within the Made Ground and zero within the natural soils with the highest readings of 1.3ppm recorded at 1.2m bgl from WS102.

Representative soil samples were subject to laboratory testing to further characterise the site soils. The soil samples did not record contaminant concentrations above the generic assessment criteria.

The elevated PID readings are likely to be attributed to the presence of TPH within the perched water at WS102 location.

The vapour risk is considered to be low at the Site within regard to the soils and groundwater. Based on the minor exceedance, the limited soil and lack of wider TPH concentrations in the soil and groundwater, together with the highly conservative assessment criteria.

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 soil surrounding the pile will be densified and high stresses induced in the surrounding ground when

driving displacement piles. These stresses increase 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 risk due to ground gas at the Site is considered to be low and the proposed structure will not be reliant upon low permeability layers to mitigate gas or vapour risk. Therefore, the risk posed to the development by the creation of preferential pathways for the migration of gas and vapor is considered to be low.

During construction safe working practices and Personal Protective Equipment (PPE) commensurate with the ground conditions and ground gas and vapour regime will be employed.

Residual Risk

Given the absence of a significant ground gas risk, lack of areas susceptible to ground gas and lack of preferential pathways post pile installation, a residual risk from ground gases to the development is not considered to be present.

5.3 Pollution Scenario 3 – Contaminated Arisings

Displacement piles do not generate soil arisings at the ground surface. However, ancillary works such as casting of pile caps may do so. It is anticipated that the arisings generated at the Site will be limited.

The 2001 EA guidance (Ref. NC/99/73) notes that “the risk from contaminated soil arisings in the case of displacement piling is considered to be negligible in most instances”. It is considered that the risks associated with contaminated arisings at the Site to be negligible.

5.4 Pollution Scenario 4 – Aggressive Ground Conditions

Source

There is the potential for aggressive ground conditions to pose a risk of degradation to installed foundation piles by chemical attack.

Based on the characteristic values derived from SD1 testing undertaken during the recent ground investigation, the Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are considered to be:

- Concrete in contact with Made Ground: DS-1 AC-1;
- Concrete in contact with Alluvium: DS-1 AC-1; and,
- Concrete in contact with Glacial Till: DS-1 AC-1.

Pathway

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

Receptor

Concrete piles and other below ground concrete structures.

Assessment

The ground investigation indicates that for foundation design purposes, concrete mixes with a design class of DS Class DS-1, ACEC Class AC-1 should be used. No significantly elevated sulphate concentrations or low pH values were recorded during the ground investigation that indicate the presence of aggressive ground conditions.

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

It is considered that the use of the correct concrete specification would remove residual risks.

5.5 Pollution Scenario 5 – Driving of Contamination Downwards

Source

The ground investigation identified marginal soil and groundwater contamination in the Made Ground and marginal hydrocarbon contamination within the Alluvium Secondary A Aquifer, consistent with typical conditions at a brownfield site with a history of industrial land use.

There is a potential risk that piling works could drive ground contamination downwards, moving Made Ground to be in direct contact with the Alluvium and Pennine Lower Coal Measures.

Pathway

The driving of soil from the Made Ground vertically downwards at the pile toe or along the sides could move marginally contaminated Made Ground into direct contact with the Alluvium and Pennine Lower Coal Measures.

Receptor

Alluvium and Pennine Lower Coal Measures Secondary A Aquifers.

Assessment

As reported in 2001 EA Land Centre Report NC/99/73, driven displacement piles may drag down contaminated material as they penetrate underlying strata. This drag down may occur by a frictional mechanism along the shaft of the pile, or by pushing material ahead of the pile shoe. However, geotechnical research on driven piles has shown that the magnitude of these effects is normally low. Material dragged down by shaft friction is unlikely to be displaced by more than a few centimetres, and theoretical calculations indicate that at most a few kilograms of soil may be pushed ahead of the pile shoe.

Given the presence of only marginal exceedances of contaminants being present at the Site and the small volume of material likely to be impacted by the piling, the risk as a result of driving of contaminated soils down to the Secondary A Aquifers during piling is considered to be low.

Residual Risk

A small volume of material (Made Ground and Alluvium) is likely to be left at the toe of the piles, as a result of the small volume and the marginal exceedances the risk to the Secondary A Aquifers following piling is considered to be low.

5.6 Pollution Scenario 6 – Concrete Entering the Groundwater or Surface Water

The driven piling method will involve the driving of steel piles, pre-cast concrete pile elements or permanent casings inside which concrete is cast. Therefore, there is considered to be a low risk of contamination as all concrete in direct contact with groundwater is hardened before being introduced into the ground.

The 2001 EA Land Centre Report NC/99/73 states that this pollution scenario not likely to be an issue if using a displacement piling method provided workmanship and QA/QC measures are appropriate.

If bentonite slurry lubricant is to be used in the installation of the piles, this will be appropriately controlled in accordance with the Contractor's Detailed Piling Method Statement to ensure that it does not impact the groundwater and the River Roch.

5.7 Piling Impact Summary

A summary of the proposed driven 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	The ground investigation identified marginal soil and groundwater contamination in the Made Ground and marginal hydrocarbon contamination within the Alluvium Secondary A Aquifer, consistent with typical conditions at a brownfield site with a history of industrial land use. Piles founded in the Pennine Lower Coal Measures will result in the Alluvium Deposits being breached and potential for preferential pathway to be formed between the Made Ground and the aquifer in the Pennine Lower Coal Measures. The soil surrounding the pile will be densified and high stresses induced in the surrounding ground when driving displacement piles. These stresses increase 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 contaminant concentrations recorded in the ground investigation indicate that the potential impact of preferential pathways would be low.	Low	A regime of groundwater monitoring will be undertaken, including sampling before, during and on completion of piling works, to confirm that piling does not negatively impact the water quality in the aquifers and the River Roch.
Scenario 2 – Ground gas and vapours	Ground investigations have recorded the Made Ground as having a low ground gas vapour generation potential, with a maximum CS-1 classification being calculated for ground gas and no elevated vapour concentrations recorded on Site. The soil surrounding the pile will be densified and high stresses induced in the surrounding ground when driving displacement piles. These stresses increase 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 risk due to ground gas at the Site is considered to be low and the proposed structure will not be reliant upon low permeability layers to mitigate gas or vapour risk. Therefore, the risk posed to the development by the creation of preferential pathways for the migration of gas and vapor is considered to be low.	Low	The ground gas regime is classified as CS-1 (very low risk) across the Site. The risk from vapours is considered to be low at the Site. Mitigation measures are therefore limited to PPE/RPE for construction workers.
Scenario 3 – Contaminated Arisings	Displacement piles do not generate soil arisings at the ground surface. However, ancillary works such as casting of pile caps may do so. It is anticipated that the arisings generated at the Site will be limited. The 2001 EA guidance (Ref. NC/99/73) notes that “the risk from contaminated soil arisings in the case of displacement piling is considered to be negligible in most instances”. It is considered that the risks associated with contaminated arisings at the Site to be negligible.	Low	N/A
Scenario 4 – Aggressive ground conditions	The ground investigation indicates that for foundation design purposes, concrete mixes with a design class of DS Class DS-1, ACEC Class AC-1 should be used. No significantly elevated	Low	Concrete designed to the correct specification.

Pollution Scenario	Assessment	Impact	Mitigation Measures
	sulphate concentrations or low pH values were recorded during the ground investigation that indicate the presence of aggressive ground conditions. Piles and below ground structures will be formed from concrete which meets this specification and using the methodology in accordance with BRE SD1 (2005).		
Scenario 5 – Driving of Contamination Downwards	As reported in 2001 EA Land Centre Report NC/99/73, driven displacement piles may drag down contaminated material as they penetrate underlying strata. This drag down may occur by a frictional mechanism along the shaft of the pile, or by pushing material ahead of the pile shoe. However, geotechnical research on driven piles has shown that the magnitude of these effects is normally low. Material dragged down by shaft friction is unlikely to be displaced by more than a few centimetres, and theoretical calculations indicate that at most a few kilograms of soil may be pushed ahead of the pile shoe. Given the presence of only marginal exceedances of contaminants being present at the Site and the small volume of material likely to be impacted by the piling, the risk as a result of driving of contaminated soils down to the Secondary A Aquifers during piling is considered to be low.	Low	A regime of groundwater monitoring will be undertaken, including sampling before, during and on completion of piling works, to confirm that piling does not negatively impact the water quality in the aquifers and the River Roch.
Scenario 6 – Concrete entering groundwater and surface water	The driven piling method will involve the driving of steel piles, pre-cast concrete pile elements or permanent casings inside which concrete is cast. Therefore, there is considered to be a low risk of contamination as all concrete in direct contact with groundwater is hardened before being introduced into the ground. The 2001 EA Land Centre Report NC/99/73 states that this pollution scenario not likely to be an issue if using a displacement piling method provided workmanship and QA/QC measures are appropriate.	Low	If bentonite slurry lubricant is to be used in the installation of the piles, this will be appropriately controlled in accordance with the Contractor's Detailed Piling Method Statement to ensure that it does not impact the groundwater and the River Roch.

6. QA/QC Procedures

The Quality Assurance (QA) and Quality Control (QC) procedures to be followed by the piling contractor will include details and records of 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, if any;
- 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 stockpiled arisings, if any;
- 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

Displacement piles do not generate soil arisings at the ground surface. However, ancillary works such as casting of pile caps may do so. It is anticipated that the arisings generated at the Site will be limited.

Where the limited 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.

7.2 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.

7.3 Monitoring for Unforeseen Contamination

If at any time the Contractor encounters unusual or unforeseen ground conditions or contamination, this is to be reported to Waterman immediately. Works in the affected area will cease, whilst risk assessment and, if required, supplementary ground investigation is completed.

Should remediation be necessary, a Remediation Strategy should be prepared which should be subject to the approval of Rochdale Council.

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 Alluvium into the underlying mudstone bedrock (Pennine Lower Coal Measures). Piles will be keyed into the Pennine Lower Coal Measures and be formed using displacement driven piles.

The ground investigation identified marginal soil and groundwater contamination in the Made Ground and marginal hydrocarbon contamination within the Alluvium Secondary A Aquifer, consistent with typical conditions at a brownfield site with a history of industrial land use.

Ground gas monitoring programme of 6No. rounds have been completed at the Site. The Qhg (borehole hazardous gas flow rate) has been determined for each borehole monitored. Assessment of the results records a maximum Qhg of 0.0005l/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 are not required.

The PID readings generally recorded <1.0ppm within the Made Ground and zero within the natural soils with the highest readings of 1.3ppm recorded at 1.2m bgl from WS102.

Representative soil samples were subject to laboratory testing to further characterise the site soils. The soil samples did not record contaminant concentrations above the generic assessment criteria.

The elevated PID readings are likely to be attributed to the presence of TPH within the perched water at WS102 location.

The vapour risk is considered to be low at the Site within regard to the soils and groundwater. Based on the minor exceedance, the limited soil and lack of wider TPH concentrations in the soil and groundwater, together with the highly conservative assessment criteria.

The potential for these contaminants to migrate into the underlying aquifers during and following the construction of the piles is considered to be Low.

Piling works should be carried out in accordance with appropriate Risk Assessments and Method Statements developed by the piling contractor.

The ground conditions reported relate only to the point of excavations during the ground investigation (April 2023) 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.

The Scheme gained planning consent (Ref: 22/01441/PSID) by Rochdale Borough Council in 2023. This report submitted to Rochdale Borough Council to support the discharge of Planning Condition 6.

8.1 Piling Method and Control Measures

The proposed driven piling methodology has been assessed against the six pollution scenarios identified by the EA.

Assessment of the driven 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;

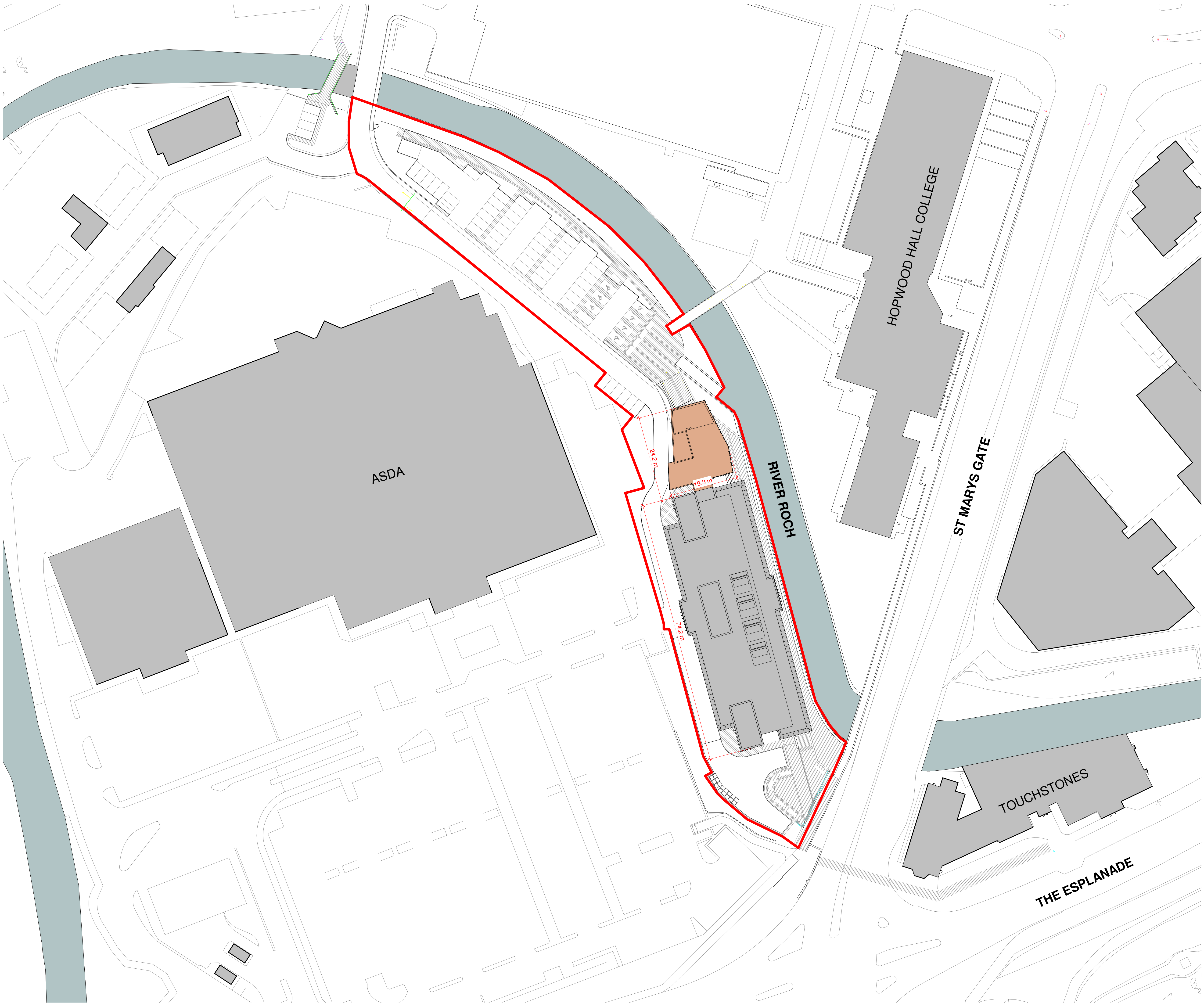
- A regime of groundwater monitoring will be undertaken, including sampling before, during and on completion of piling works, to confirm that piling does not negatively impact the water quality in the aquifers and the River Roch;
- Construction workers should wear the appropriate PPE/RPE during construction works at the Site;
- The ground investigation indicates that for foundation design purposes, concrete mixes with a design class of DS Class DS-1, ACEC Class AC-1 should be used;
- If bentonite slurry lubricant is to be used in the installation of the piles, this will be appropriately controlled in accordance with the Contractor's Detailed Piling Method Statement to ensure that it does not impact the groundwater and the River Roch.
- The Quality Assurance (QA) and Quality Control (QC) procedures to be followed by the piling contractor will include details and records of all items detailed in Section 6 of this report.

APPENDICES

A. Site Plans

- Proposed Site Plan (Ref: 3940-A-1002P)
- Groundwater Exceedance Plan (Ref: 19085-100-WIE-ZZ-XX-DR-V-80-0002)

Appendices



NOTE:
1. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ARCHITECT.
2. ALL DIMENSIONS TO BE SITE CHECKED & VERIFIED BY THE CONTRACTOR PRIOR TO THE MANUFACTURE OR ORDER OF ANY MATERIALS OR GOODS.

KEY:
— PROPOSAL BOUNDARY



P2	Planning Permission Submission	02.11.22
P1	Issued for comment	28.10.22
Rev	Description	Date

PLANNING
Rochdale Sixth Form College
College Road, Rochdale, OL12 6HY

Proposed Site Plan

DRAWING NUMBER
3940-A-1002P

DATE 10/25/22	REVISION P2	STATUS PURPOSE OF ISSUE
------------------	----------------	----------------------------

ABW architects Ltd.
architecture building workshop

A1
©

02110202 15:21:16

We are Waterman, where every project matters

We deliver progressive, sustainability-driven environmental and engineering consultancy services across every sector. We think differently, and we're harnessing our collective expertise to deliver greener, healthier and well-connected communities, networks and built environments.

Based in strategic locations throughout the UK and Ireland, our team of specialists is at the forefront of tackling the climate emergency and forging a path to a Net Zero built environment.

UK & Ireland Office Locations

