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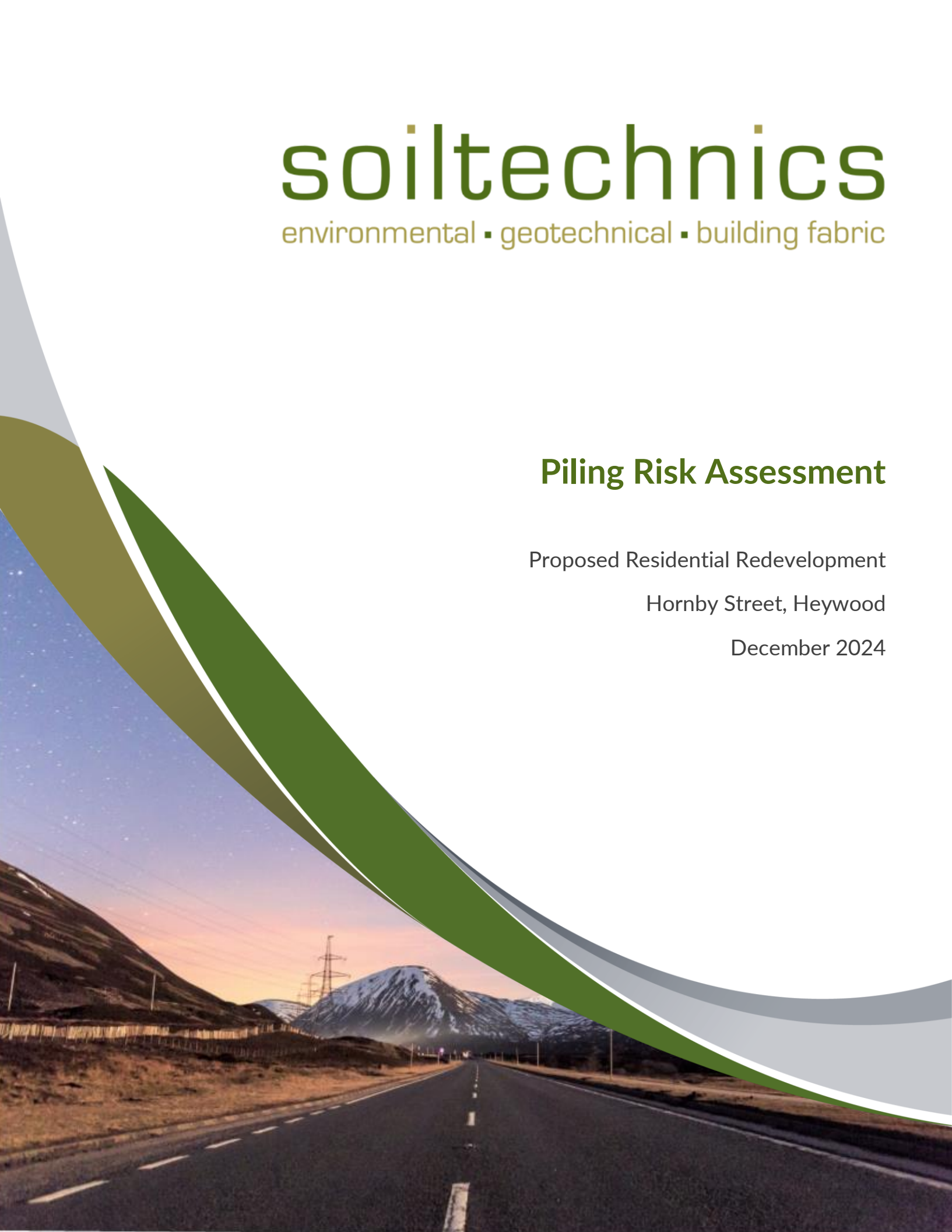
environmental • geotechnical • building fabric

Piling Risk Assessment

Proposed Residential Redevelopment

Hornby Street, Heywood

December 2024



Project Details

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1 Introduction

1.1 Scheme Outline

- 1.1.1 The proposed development is located off Hornby Street, Heywood, and it is understood that the proposed schedule of accommodation is 12No. units with 1No. unit for ancillary space for worker accommodation. Development proposals are presented in Appendix A.
- 1.1.2 The development scheme is controlled by Rochdale Metropolitan Borough Council under the planning reference: 23/01382/FUL.
- 1.1.3 The report is based on the project proposals and information outlined above; should the scheme change then it will be necessary to review the conclusions and recommendations presented in this report.

1.2 Brief

- 1.2.1 This report has been prepared following instructions received from our client, R&M Property Ltd. The overall brief of works is to complete a piling risk assessment in order to satisfy the requirements of the Environment Agency.
- 1.2.2 The objectives of this report are outlined below:
- i) Review the findings of previously undertaken ground investigations.
 - ii) Produce a risk assessment and method statement for proposed piling works in consideration of the possible migration of any identified contamination to underlying groundwater and surface waters during piling operations.

1.3 Guidance Documents

- 1.3.1 This report has been prepared based on our understanding of current best practice and specifically following guidance provided in the following documents.

Title	Document Reference	Publisher
Piling in layered ground: risks to groundwater and archaeology;	Science Report SC020074/SR, 2006.	Environment Agency
Piling into Contaminated Sites	NG&CLC report, 2002, (archived)	Environment Agency
Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention	NG&CLC report NC/99/73, May 2001, (archived)	Environment Agency

Table 1-A: Guidance documents

1.4 Previous Reports

1.4.1 This report incorporates and relies on information contained in the following reports:

Author	Document Title	Date & Document Reference	Report Context
Soiltechnics Ltd	Preliminary Risk Assessment and Coal Mining Risk Assessment	STV6299-R01-Rev_B December 2023	Desk based risk assessment of potential geoenvironmental and geotechnical hazards. Assessment of risk associated with coal mining
Soiltechnics Ltd	Ground Investigation Report	STVW6573-R01_Rev_A February 2024	Ground Investigation Report including assessment of geotechnical, geoenvironmental and mining hazards. Includes appropriate PRA and GQRA contaminated land risk assessments to support the development.

Table 1-B: Summary of previous reports

1.5 Limitations

1.5.1 Soiltechnics disclaims any responsibility to our Client and others in respect of any matters outside the scope of this report. This report has been prepared with reasonable skill, care and diligence in accordance with the terms of our contract, taking account of the resources, investigations and testing devoted to it by agreement with our Client. This report is confidential to our Client and Soiltechnics accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

2 Site Setting

2.1 Site Location

- 2.1.1 The proposed development lies within Heywood, approximately 400m southeast of the town centre. The post code for the site is OL10 1BH, and the site is accessed from Hornby Street which lies adjacent to the site's eastern boundary.
- 2.1.2 An aerial image showing the approximate site boundary is presented below, followed by a table summarising the key site features. A Site Plan is provided within Appendix A.



Figure 2-A: Aerial photograph and approximate site boundary

- 2.1.3 The site is currently an undeveloped grassed area with a hardstanding track along the western boundary, which provides access to the rear of residential properties off Stanley Street. A concrete panel fence aligns the western edge of the grassed area.
- 2.1.4 The site is located within a residential area, with Heywood Park Primary School is located to the northeast of the site.
- ### 2.2 Site Geology
- 2.2.1 A summary of the geology across the site is provided below.

Stratum	Brief description	Top depth range (m bgl)	Thickness (m)
Topsoil	Dark brown sandy clay.	G.L	0.20 – 0.30
Made Ground (localised deposits)	Grey sandy gravelly clay with ash, glass, plastic and brick.	0.2 - 0.25	0.15 – 1.0
Glaciofluvial Deposits	Gravelly clay and silt with sand lenses.	0.15 – 1.3	6.10 – 7.85
	Localised bed of peat within WS01, WS02, RBH101.	0.8 – 1.65	0.35 – 1.90
Penning Lower Coal Measures	Not encountered. Typically interbedded siltstones, mudstones and coal.	7.00 to 8.00m	Basal unit.

Table 2-A: Ground model

2.3 Hydrogeology & Groundwater Sensitivity

2.3.1 The general hydrogeological profile of the site is provided in the table below.

Stratum	Aquifer Designation	Groundwater commentary
Glaciofluvial Deposits	Secondary A	Variable due to low permeability bands and strata. Groundwater expected between 1m and 4.5m, with localised perched water at shallow depths.
Pennine Lower Coal Measures	Secondary A	Assumed to be water bearing at depth/in fractures

Table 2-B: Hydrogeological model

2.3.2 Groundwater levels are expected to vary seasonally and in response to weather events.

2.3.3 The site is not located within a Source Protection Zone.

2.3.4 The nearest groundwater abstraction point is some 505m east of the site for use as process water for a tannery.

2.4 Chemical Contamination

2.4.1 The site itself has remained undeveloped throughout history. The immediate surrounding area has been largely residential with the exception of reservoirs immediately north of the site associated with Stanley Mill 80m north of the site. The reservoirs were infilled in 1969 and the mill disused around the same time.

2.4.2 Sporadic exceedance of non-volatile PAHs and lead have been encountered in shallow soils across the site, which is typically of shallow diffuse contamination in urban environments.

2.4.3 No visual or olfactory evidence of contamination was observed within the ground investigation.

2.4.4 The Ground Investigation Report identified a low risk to controlled waters. Therefore, the construction works are unlikely to lead to a significant deterioration in groundwater quality.

2.5 Gaseous Contamination

2.5.1 Possible unrecorded shallow coal workings were identified within the desk study, associated with the Arley seam which was suspected to be ~0.5m thick at 15m bgl. This was investigated through a series of rotary boreholes to support a Coal Mining Risk Assessment. present beneath the site, at a depth of 15m bgl, associated with the Arley Seam.

- 2.5.2 A rotary borehole progressed to 30 m bgl, and did not encounter any evidence of coal, or broken or voided ground (which would be indicative of mine workings). The Arley Coal seam, if present, was concluded to not have been worked below the site. The Coal Mining Risk Assessment went on to further discuss the risk from mine gas, due to the absence of shallow workings and shafts, and the presence of low permeability superficial deposits and a shallow groundwater table, the report concluded the site was at a very low risk of mine gas emissions.
- 2.5.3 The desk study did not identify any other potentially significant sources of ground gases and no elevated levels of carbon dioxide or methane were detected during the monitoring of shallow ground gas wells, and a shallow groundwater table is present.
- 2.5.4 Due to the absence of a significant actively generating ground gas source site, absence of a highly permeable migration pathway (such as a mine shaft), and presence of low permeability soils, the site is not considered to be at an unacceptable risk from hazardous ground gas.

3 Review of Piling Methods

3.1 Introductions

3.1.1 There is a wide variation in the design and installation methods used within the piling industry. As a result, a number of different approaches to creating a generic classification system may be taken.

3.1.2 The NG&CLC report NC/99/73 identified three main basic types of pile foundations:

- Displacement piling (such as driven piles).
- Non-displacement and replacement piling (such as CFA).
- Penetrative ground improvement (such as vibro stone columns).

3.2 General Characteristics of CFA Piles

3.2.1 Non-displacement piling techniques, such as CFA, involve the extraction of a core of soil and its subsequent replacement by the pile. Excavated soil is brought to the ground surface in the form of arisings, and the pile is formed by casting concrete in situ. Displacement of the soil surrounding the pile is minimised and there is minimal radial or vertical soil movement or densification as a result of this method.

3.3 General Characteristics of Driven Piles

3.3.1 Small driven (displacement) piles comprise steel sheet, H, I, hollow tube sections, or hybrids such as auger piles. Large displacement piles may consist of pre-cast concrete elements, closed-end steel tube or timber sections or may be cast in situ inside a casing or in a pre-formed void. Displacement piling methods involves the pile being forced into the ground, which then causes the soil to be displaced without the removal of soil to the ground surface.

3.3.2 Soil displacement occurs generally in a radial horizontal direction and there is little downwards vertical movement of soil under the toe of the pile. In general, the mechanism of radial soil displacement leads densification of the soil surrounding the pile and generally this will lead to a reduction in permeability of the penetrated soil.

3.4 General Characteristics of Ground Improvement Piles

3.4.1 Ground improvement solutions are varied and can include the compaction and densification, often undertaken in tandem with the installation of granular or rigid inclusions, such as vibro stone or controlled modulus columns.

4 Adopted Foundation Solution

4.1 General Approach

- 4.1.1 Due to the variable compaction and potential for void spaces to be present within the Made Ground, the geotechnical solution for the site comprises piled foundation, keying into underlying Pennine Lower Coal Measures Formation.
- 4.1.2 It is understood that 220mm and 273mm diameter bottom driven steel tubular piles will be installed across site. Ground beams will be integrated as concrete is poured.
- 4.1.3 A minimum pile length of 7.5m is recommended, founded into the Pennine Lower Coal Measures Formation. This should have sufficient resistance to accommodate the working loads up to 170 kN and 250 kN for the 220mm diameter piles and 273mm diameter pile respectively. Static calculations assume minimum 0.5m penetration into the Pennine Lower Coal Measures.
- 4.1.4 The Pile Design report are included in Appendix B, and a method statement for the piling works are included within Appendix C.

5 Piling Risk Assessment

5.1 General Context

5.1.1 With regards to piling activities, concerns about water protection are likely to be most severe when:

- Contaminants are present on the site and groundworks may allow them to migrate.
- Piling would breach a low permeability layer or connect two previously discrete aquifers.
- The site overlies a Principal or Secondary Aquifer.
- The site is located within a Source Protection Zone.
- The water table is shallow or likely to be intersected by piles.
- The geological strata are fractured or fissured.
- Works are close to a surface water body and run-off from arising's could contaminate such waters.

5.1.2 The main concerns in relation to piling and the impact on controlled waters are as follows:

- The creation of preferential flow paths, allowing contaminated groundwater and leachates to move downwards through aquitard layers.
- The breaching of impermeable covers by piling or penetrative ground improvement, allowing surface water infiltration into contaminated ground (thus creating leachate) or allowing the escape of landfill or ground gases.
- Contaminated arising's 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.
- The effects of aggressive ground conditions on materials used in piles.
- Driving contaminated materials downwards into an aquifer during construction/installation.
- Concrete or grout contamination of groundwater and any nearby surface waters.

5.1.3 The Environment Agency's decision in relation to piling proposals will be based on the overall risk that such operations are likely to present, the techniques used, mitigation measures used (if any) and proposed quality assurance and control methods.

5.2 Source-pathway-receptor (SPR) linkages scenarios

5.2.1 Six potential S-P-R linkages have been considered by the Environment Agency, as follows. The scenarios are described in detail in the following sections.

1. Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer.
2. Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface.
3. Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.
4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration).
5. The driving of solid contaminants down into an aquifer during pile driving.
6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.

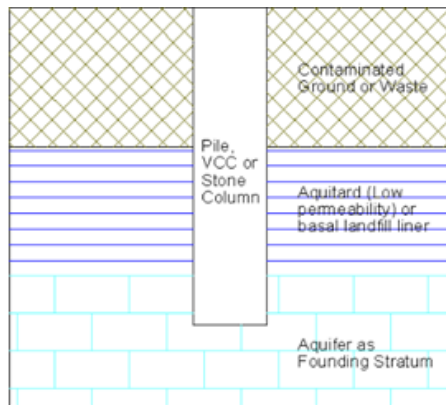
Scenario 1: Creation of preferential pathways, through an aquitard, to allow potential contamination of an underlying aquifer.

General Context:

Contaminated soils and/or groundwater may migrate along a pile stone column, pile/soil interface or through disturbed ground located immediately adjacent to the pile and into the aquifer at depth in which the pile is end bearing.

Typically, contaminated ground is situated above a clay layer which overlies aquifer bearing strata such as Chalk. Perched groundwater may exist above the clay layer which prevents downward migration. Penetration of the aquitard layer may potentially create a migration pathway for contaminants.

Schematic:



General Considerations:

- Are there polluting substances in the ground that are in a leachable or mobile form?
- Is the groundwater directly underneath the site, or in strata penetrated by engineered structures, considered to be in a Principal or Secondary Aquifer, or is the groundwater in hydraulic continuity with a surface water body?
- Will the piling or ground improvement method of choice breach a low permeability layer (aquitard) or the basal liner of a closed landfill site, or penetrate an aquifer?
- Is there a hydraulic gradient that could cause contaminants in near surface deposits to migrate into an underlying aquifer or surface water body?
- Is the pile made out of a material (e.g. timber) that could allow passage of contaminants?
- Will the piling or ground improvement method of choice have the potential to create a preferential flow path for the migration of contaminated perched water or leachate into an aquifer or surface water body?

Discussion:

Sporadic exceedances of lead and PAHs have been encountered within topsoil deposits across the site. As part of the development topsoil deposits are being stripped across the site prior to piling.

The underlying Pennine Lower Coal Measure Formation is classed as a Secondary A aquifer. The driven piled solution will likely pile through the overlying soft and interbedded cohesive deposits and onto the top of bedrock, classed as a Secondary A aquifer.

As the clay is typically soft and saturated, the clay would be expected to seal around pile columns and prevent the creation of a preferential pathway.

Outcome:

Low risk for all pile types.

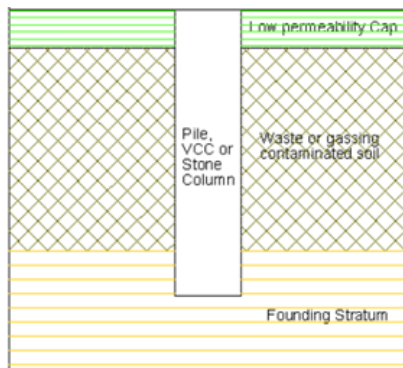
Scenario 2: Creation of preferential pathways to allow migration of landfill gas, soil gas or contaminant vapours to the surface.

General Context:

Gases derived from landfill waste or contaminated ground may migrate into the development via pathways created by pile/stone columns, along the pile/soil interface or through disturbed ground located immediately adjacent to the pile.

Typically, this scenario will be encountered where the development is constructed over a former landfill site or over potentially gas generating fill (used to raise levels), or where volatile hydrocarbon contamination exists. An impermeable cap may be present which manages the gassing regime.

Schematic:



General Considerations:

- Is the contamination considered to present a potential source of either landfill gas (for example, waste materials giving rise to methane, sulphur dioxide and carbon dioxide) or volatile organic compounds (for example, BTEX volatilising from hydrocarbon contaminated soils)?
- Will the piling or ground improvement method of choice have the potential to create a preferential flow path for the migration of gas or vapour to surface?
- Will the risks arising from accumulation of landfill gas or contaminant vapours in enclosed spaces in the proposed development be mitigated by the incorporation of standard gas protection measures into the building design?
- Is the release of gases to atmosphere acceptable from an air quality point of view?

Discussion:

Ground gas monitoring has indicated that no elevated levels of carbon dioxide or methane are present on site.

The Coal Mining Risk Assessment has concluded that there is a very low risk from mine gases.

No significant actively generating ground gas source has been identified on or within the vicinity of the site. Site is classified as CS-1.

Outcome:

Low risk for a driven and CFA piled solutions. Granular piles (e.g. stone columns) should be avoided as a precaution.

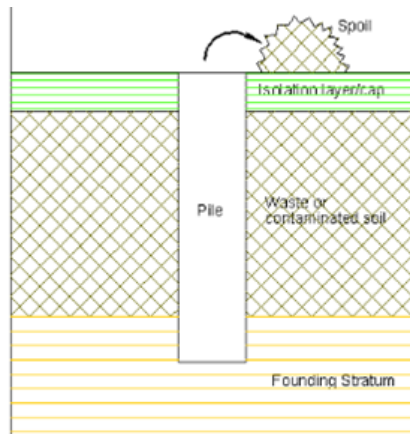
Scenario 3: Direct contact of site workers and others with contaminated soil arising's that have been brought to the surface.

General Context:

Construction workers may come into direct contact with contaminated arisings from piling works, from which contamination may also run-off and migrate towards surface waters.

Typically, if contamination is present at the site, piling works are likely to mix contaminated and uncontaminated soils leading to an increase volume of contaminated soils requiring offsite disposal. Such arisings are likely to provide a risk of causing harm to human health and potentially to surface waters. Where arisings fulfil the definition of controlled waste, there is a 'duty of care' on the operator to ensure the safe disposal of that material.

Schematic:



General Considerations:

- Are contaminants present in the soil or groundwater at sufficient concentrations to pose a hazard to human health or the environment?
- Will the piling or ground improvement method of choice have the potential to bring potentially contaminated soil arisings to the surface?
- Are measures in place to contain and dispose of arisings in a safe manner?

Discussion:

Driven piles create minimal surface spoil and are generally low risk.

Investigations carried out to date have shown no significant contamination has been encountered at depth on site. Any contamination associated with topsoil deposits will be stripped from site as part of the enabling works phase.

No acute risk to construction workers from asbestos or any other contaminants have been identified. Therefore, standard PPE and hygiene precautions would be adequate to protect against health risks.

Outcome:

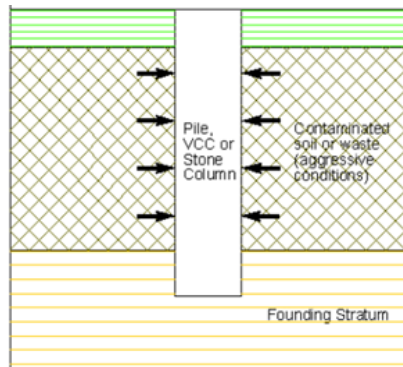
Low risk for all pile types.

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

General Context:

Contaminated soils/waste or leachate in direct contact with the pile may cause degradation of the materials used to construct such. Some contaminants maybe be extremely aggressive towards construction materials and may reduce or eliminate their load carrying capacity, potentially resulting in failure of the structure, in addition to potentially creating migration pathways.

Schematic:



General Considerations:

- Does the nature of the soil or leachate contamination present a risk to the performance or durability of the pile material?

Discussion:

The ground investigation assessed the nature of ground conditions at the site.

Aggressive ground conditions have not been identified, and a concrete class DS-1 AC-1s should apply.

No precautions against other potential aggressive conditions such as magnesium or ammonia are required.

Outcome:

Low risk to all concrete piles. Concrete classification DS-1 AC-1s should be adopted.

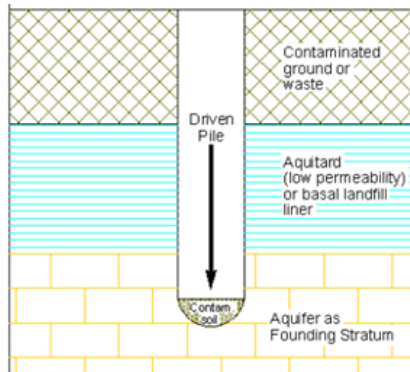
Scenario 5: The driving of solid contaminants down into an aquifer during pile driving.

General Context:

Contaminated soils may potentially be driven down into the underlying aquifer during piling operations either from being in contact with the side and end of the pile or by 'plugging' of an open-ended pile.

During piling works, soils are primarily displaced laterally but there is the potential for soil in contact with the sides and base of the pile to be dragged down slightly before being displaced laterally. Open ended tubular piles may also become 'plugged' causing near surface soils to be transported down to founding level. The effects of this can be significantly reduced with the use of a pointed or convex driving shoe.

Schematic:



General Considerations:

- Are there polluting substances in the ground that are in a leachable or mobile form?
 - Is the groundwater directly underneath the site, or in strata penetrated by engineered structures, considered to be in a Principal or Secondary Aquifer or is the groundwater in hydraulic continuity with a surface water body?
 - Will the piling or ground improvement method of choice breach a low permeability layer (aquitard) or the basal liner of a closed landfill site or penetrate an aquifer?
 - Does the chosen piling method involve use of blunt-ended solid or closed-end piles that could drag down soil or open-ended tubular piles that could become 'plugged' with soil?
-

Discussion:

Contamination associated with the topsoil on site will be removed as part of the topsoil strip prior to piling works. No other significant solid contamination has been encountered on site.

Outcome:

Low risk for all pile types.

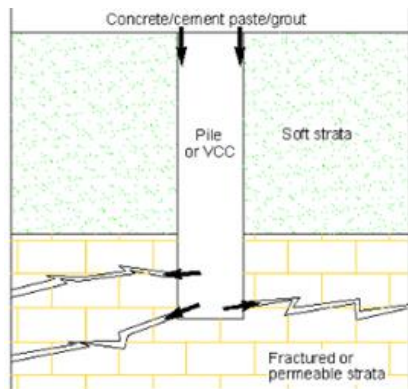
Scenario 6: Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.

General Context:

Groundwater or surface waters may become contaminated with concrete/cement paste or grout used during piling operations which flows within highly permeable or fractured strata.

Loss of concrete, cement paste, or grout may occur in fast flowing groundwater, typically associated with limestone/chalk deposits or permeable gravel formations. Until the concrete, cement paste or grout sets (which is typically in minutes), migration may occur. Use of retarder additives could extend this setting period to a few hours; however, their effectiveness would be reduced by dilution. The impact of such a scenario is likely to be localised.

Schematic:



General Considerations:

- Does the chosen piling or penetrative ground improvement method involve the introduction of wet concrete, cement paste or grout into the ground?
- Is the groundwater directly underneath the site, or in strata penetrated by engineered structures, considered to be in a Principal or Secondary Aquifer or is the groundwater in hydraulic continuity with a surface water body?
- Is the aquifer characterised by highly fissured or granular strata?
- Is the groundwater in the aquifer fast-flowing?

Discussion:

Driven piles are pre-cast and do not pose a risk in this scenario.

The site is not near a groundwater abstraction point or within a SPZ.

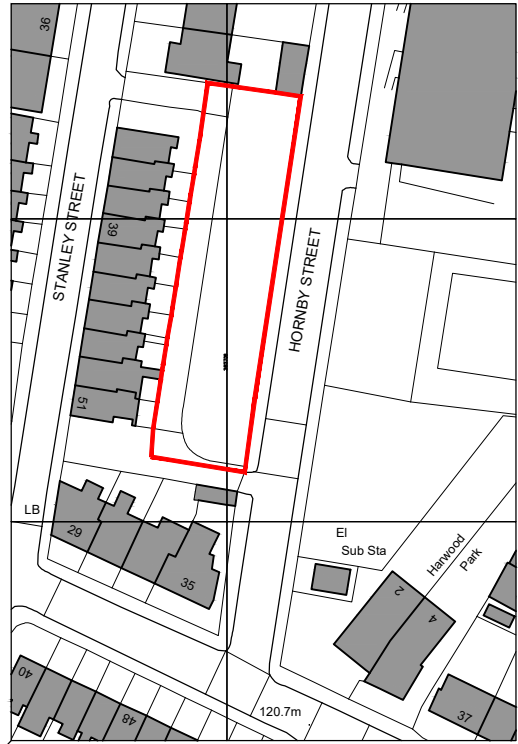
Outcome:

Negligible risk for driven piles. Low risk for all other pile types.

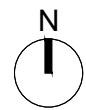
6 Conclusion

- 6.1.1 The preferred piling solution on site is driven piles.
- 6.1.2 Sporadic contamination has been encountered within topsoil deposits which will be stripped from site prior to piling, and the site is at a low risk from ground gases.
- 6.1.3 The risk assessment does not indicate any risk unacceptable risk posed to the underlying Secondary A Aquifers from a driven piled solution. No mitigation measures are required on site.

Appendix A Drawings



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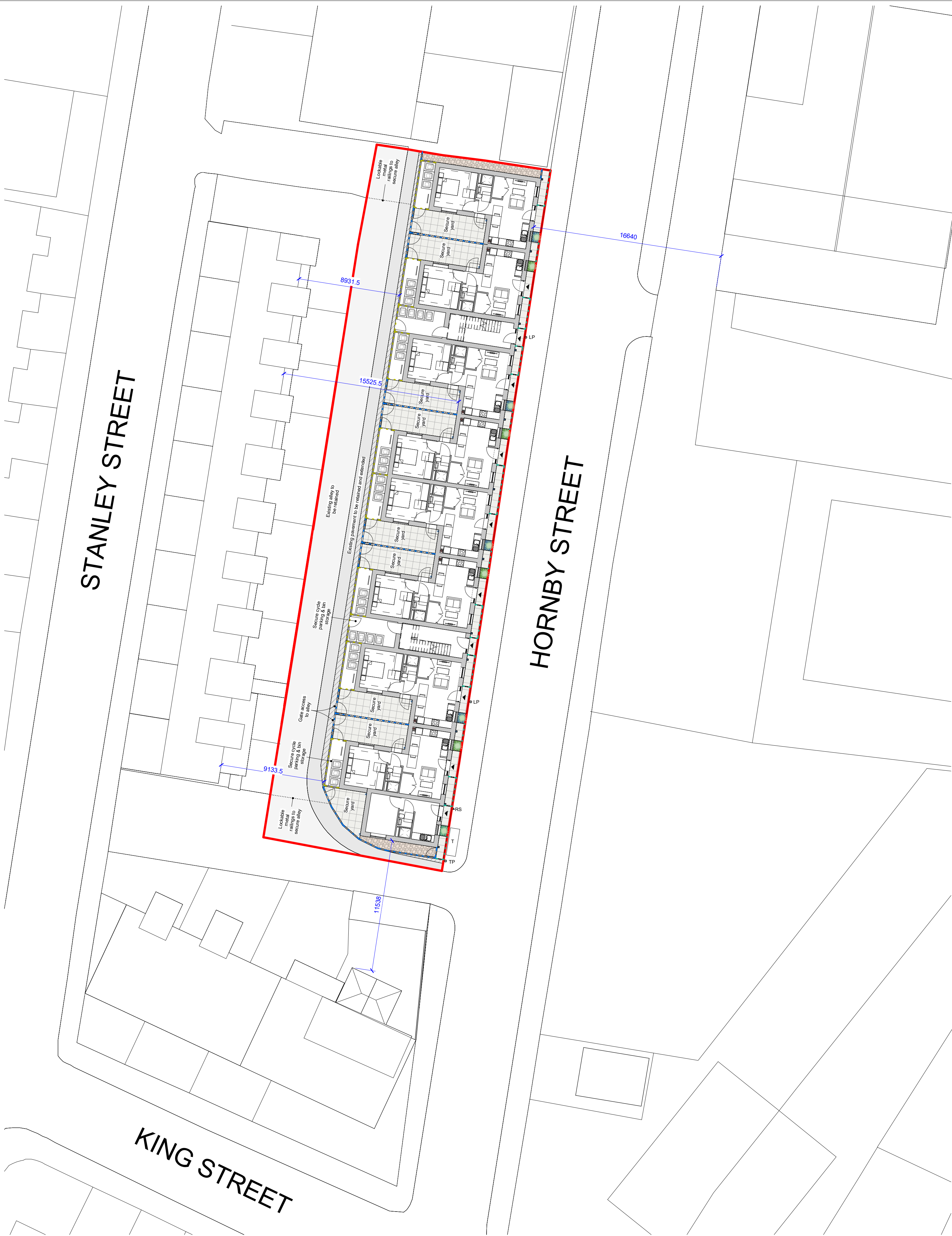
— Site Boundary - (0.1Ha)

Existing Buildings

scale 1:1250 0 50m

A 20.12.23 JH Submitted for full planning application.

Client: Cornerstone Place		Project: Hornby Street, Heywood			Drawing Name: Site Location Plan							
 Tel: 0161 272 3500 E-mail: studio@trianglearchitects.co.uk Web: www.trianglearchitects.co.uk Twitter: @TriangleArch ©TRIANGLE ARCHITECTS LIMITED Lower Ground Floor, 4 Jordan Street, Manchester, M15 4PY		Date:		Scale @ A4:	Project Number:		Drawing Number:		Drawing Purpose:		Revision:	
		Dec 2023		1:1250	23-031		01		PLANNING		A	
		Drawn:	Checked:	Status:	Project	Originator	Vol/Sys	Level	Type	Role	Number	
JH	AJD											



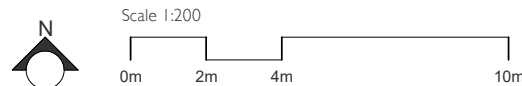
Proposed Site Plan
1 : 200

Site Plan Legend

- Planting in planters to the front of dwellings
- Paving to front gardens and secure yards
- Existing pavement to be retained
- Extension to existing pavement
- Existing alley to be retained
- Maintenance strip
- Lampost / telegraph pole (lamposts to be re-located)
- Road Sign (to be re-located)
- Telecom Inspection Chamber

- Site boundary 0.1Ha
- Overlooking distances

- Full height close boarded timber fence
- Half height metal railings
- Single brick wall (to attach to roof)



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DRAWING TO BE READ IN CONJUNCTION WITH THE HEALTH & SAFETY PLAN, AND ALL RELEVANT RISK ASSESSMENTS AND THE FOLLOWING DRAWINGS:

DRAFT

P03	18.12.23	Revised to add annotations and site key.
P02	28.11.23	Revised in line with clients comments for DTM.
P01	24.11.23	Draft issue for comment.

Rev Date By Remarks

Client:	Cornerstone Place					
Project Name:	Hornby Street, Heywood					
Drawing Name:	Proposed Site Plan					
Drawing Purpose:	Preliminary					
Project Number:	23-031					
Drawing Number:	02					
Revision:	P03					
Project	Origin	Vol/Sys	Level	Type	Role	Number
Status	Scale @ A1	Drawn	Checked	Date		
As indicated	JH	AJD	Nov 2023			

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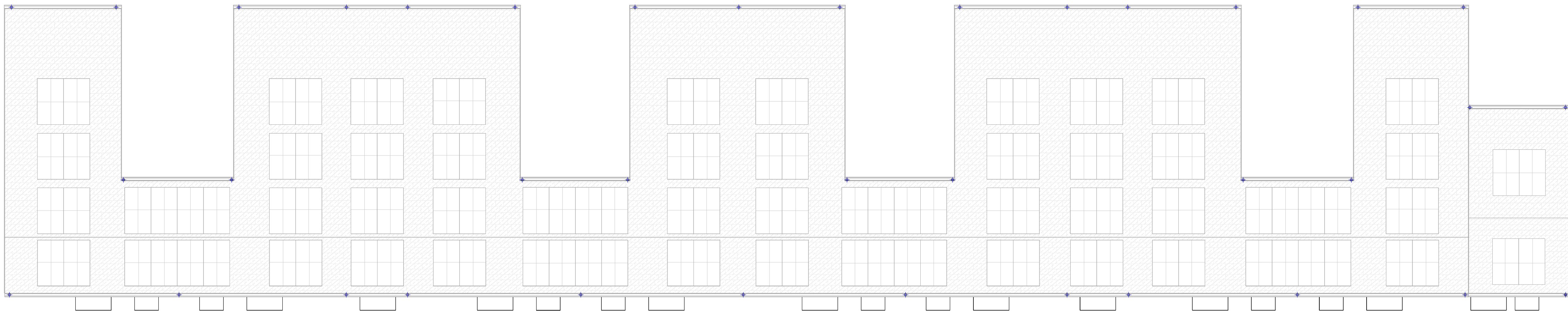
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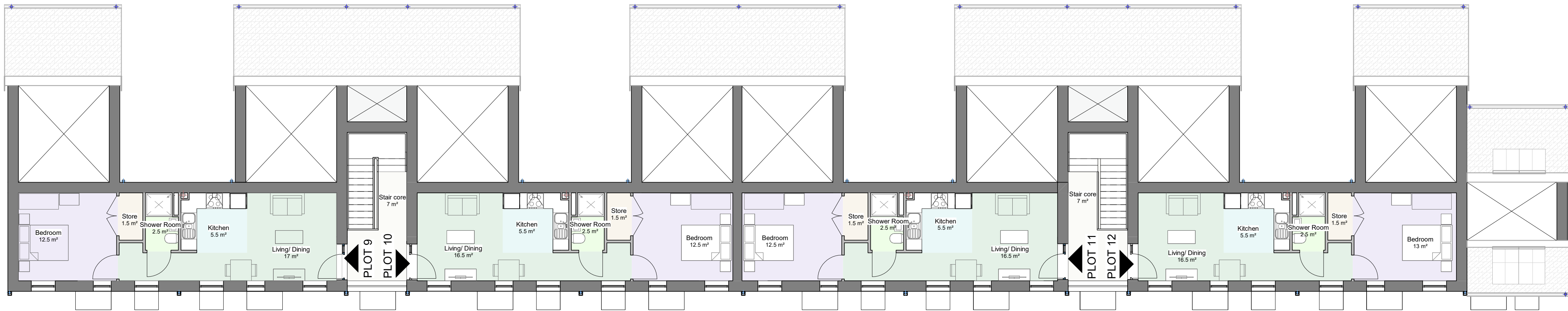
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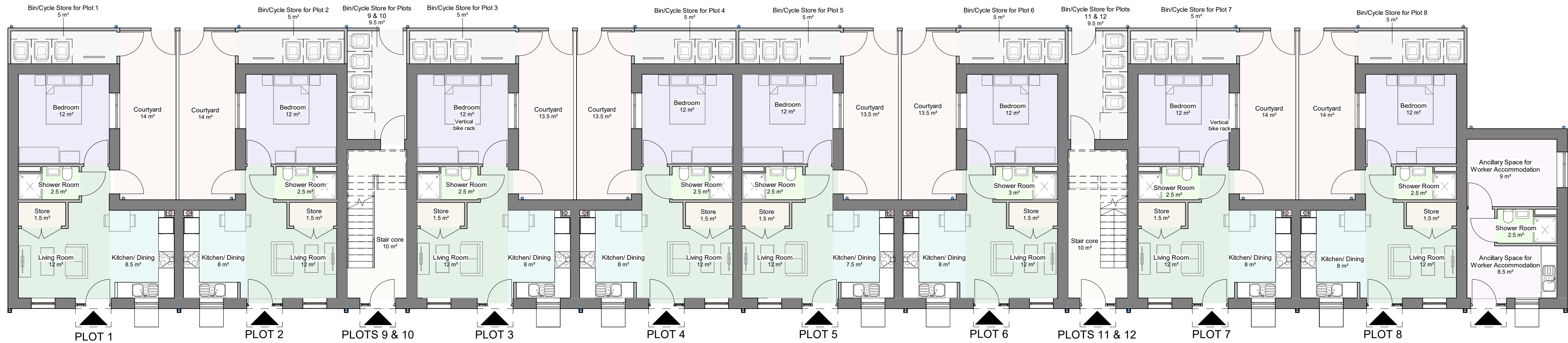
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Roof Plan
1:100



First Floor Plan
1:100



Ground Floor Plan
1:100



B 15.02.24 Amended in line with planning comments.
A 20.12.23 Submitted for full planning application.

Rev Date By Remarks

Client:

Cornerstone Place

Project Name:

Hornby Street, Heywood

Drawing Name:

Proposed Floor Plans

Drawing Purpose:

PLANNING

Dwg no.	Project	Origin	Vol/Sys	Level	Type	Role	Number
TR no.	Project Number:	23-031		TRI dwg no:	03		Revision
							B
Status	Scale @ A1	Drawn	Checked	Date			
	1 : 100	JH	AJD	Dec 2023			



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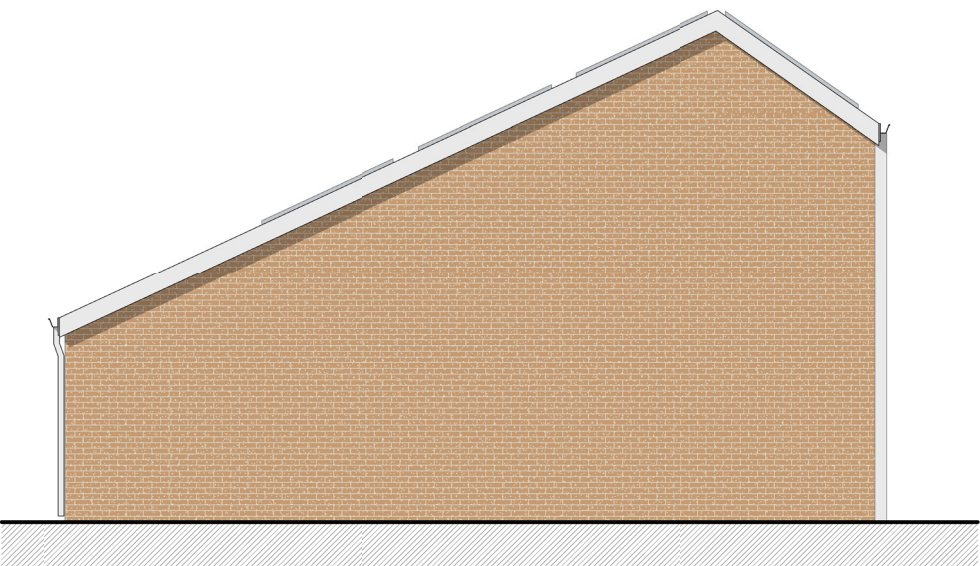
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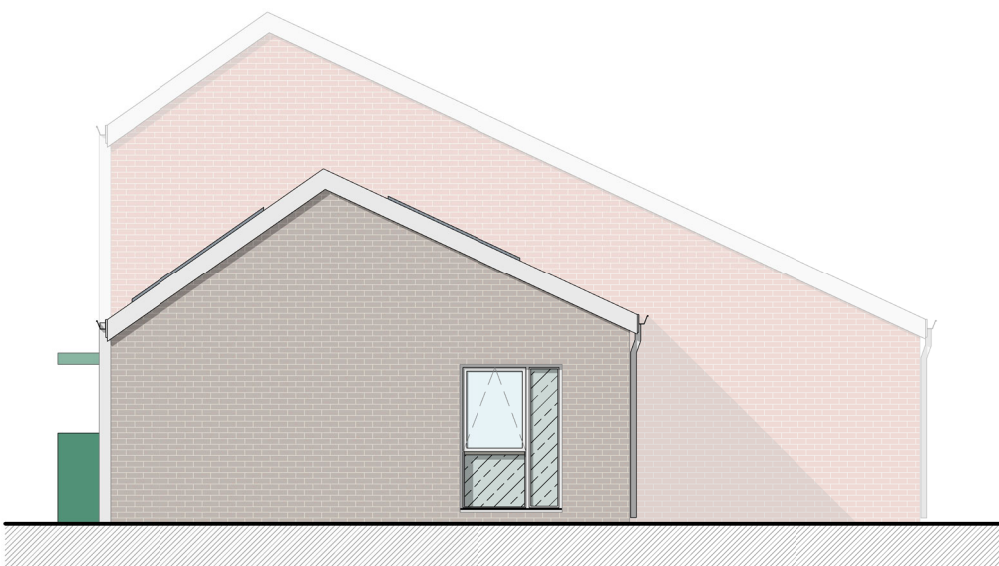
Front Elevation
1:100



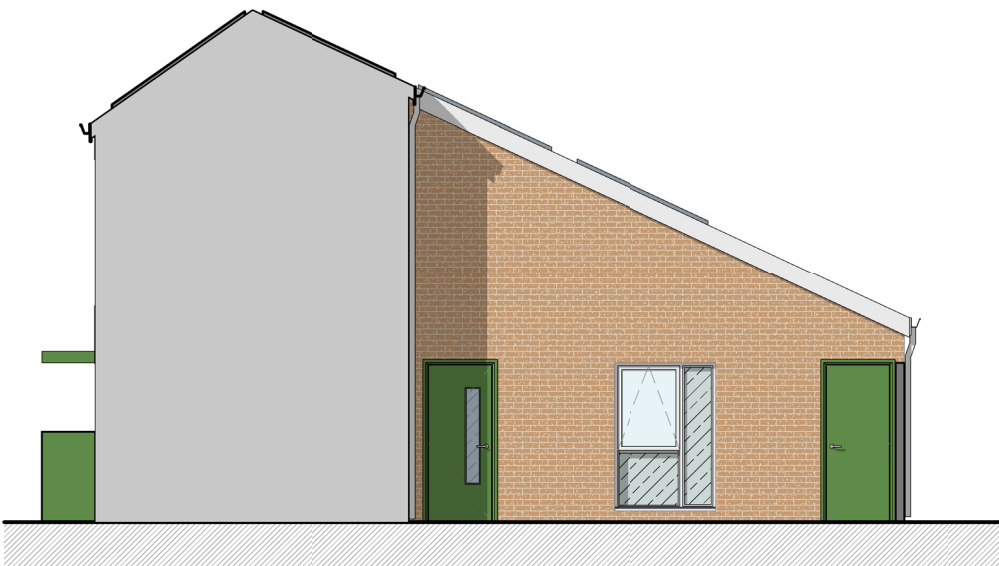
Rear Elevation
1:100



Side 1 Elevation
1:100



Side 2 Elevation
1:100

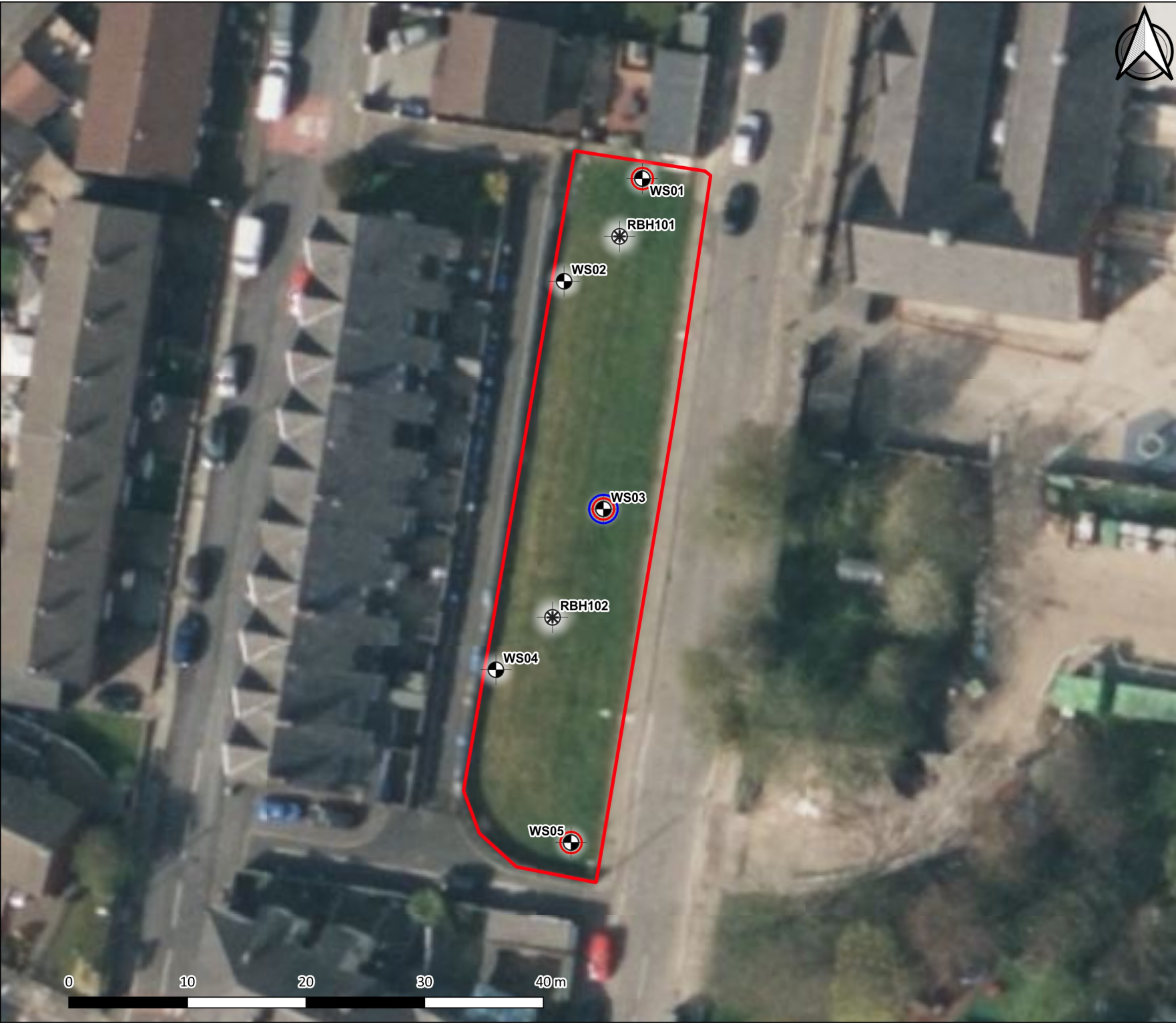


External Courtyard Elevation
1:100

B 15.02.24 Amended in line with planning comments.
A 20.12.23 Submitted for full planning application.

Rev Date By Remarks

Client:							
Cornerstone Place							
Project Name:							
Hornby Street, Heywood							
Drawing Name:							
Proposed Elevations							
Drawing Purpose:							
PLANNING							
Dwg no.	Project	Origin	Vol/Sys	Level	Type	Role	Number
Ref no.	Project Number:			TRI dwg no:		Revision	
	23-031			04		B	
Status	Scale @ A1	Drawn	Checked	Date			
1 : 100	JH	AJD	Dec 2023				



Key:

Exploratory Holes

-  Rotary Borehole
-  Windowless Sampling Borehole
-  Monitoring Well Installation
-  Infiltration Testing

Site Features

-  Site Boundary

Notes

- 1) Base image provided by Google.
- 2) All drawn features are approximate.

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A	Sept 2024	First issue
REV	DATE	COMMENT ON VARIATION

soiltechnics
environmental • geotechnical • building fabric

PROJECT
Hornby Street, Heywood

TITLE
Exploratory Hole Location Plan

DRAWING No.
STW6573-D01-A

Appendix B Piling Designs

UNIT 23 | CHILTERN TRADING ESTATE |
EARL HOWE ROAD | HIGH WYCOMBE | HP15 6QT
www.piledesigns.co.uk | 01494 216333



PILEDESIGNS

HEYWOOD – LAND OFF HORNBY STREET

BEARING PILE DESIGN CALCULATIONS

27819-BP

Document Control

Project:	Heywood – Land off Hornby Street		
Site Address:	Land off Hornby Street, Heywood, Lancashire, OL10 1AA		
Document Title:	Bearing Pile Design Calculations		
Project No.	27819		
Calculation Reference:	BP	Revision:	C0
Document produced for (Client):	K&B Piling & Groundworks Limited		

Issue Register

Rev	Date	Issue Status / Description	Prepared By	Checked By
C0	10/12/2024	For Comment /Approval	Craig Burton	David Illingworth



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1.0 Introduction

It is proposed to construct a new residential property which is to be founded on bearing piles at Land off Hornby Road, Heywood, Lancashire. It is understood that bottom driven steel tubular piles will be installed across the site and these calculations are for the static design of the envisaged pile lengths.

The site, centred at approximately National Grid Refence SD 85703 10445, is approximately rectangular shape and comprises of undeveloped grassland. A hardstanding track is noted along the western boundary which provides access to the rear of the residential properties off Stanley Street. No significant vegetation is present within the site boundaries however some mature trees are noted immediately adjacent to the site. The site is inferred as level.

The site is set in a predominantly residential area and is bounded by residential properties to the north, west and south and by Hornby Street to the east. Heywood Park Primary School is located beyond Hornby Street to the north east of the site. A site location plan and aerial photograph of the site and surrounding area is presented in figure 1 below.

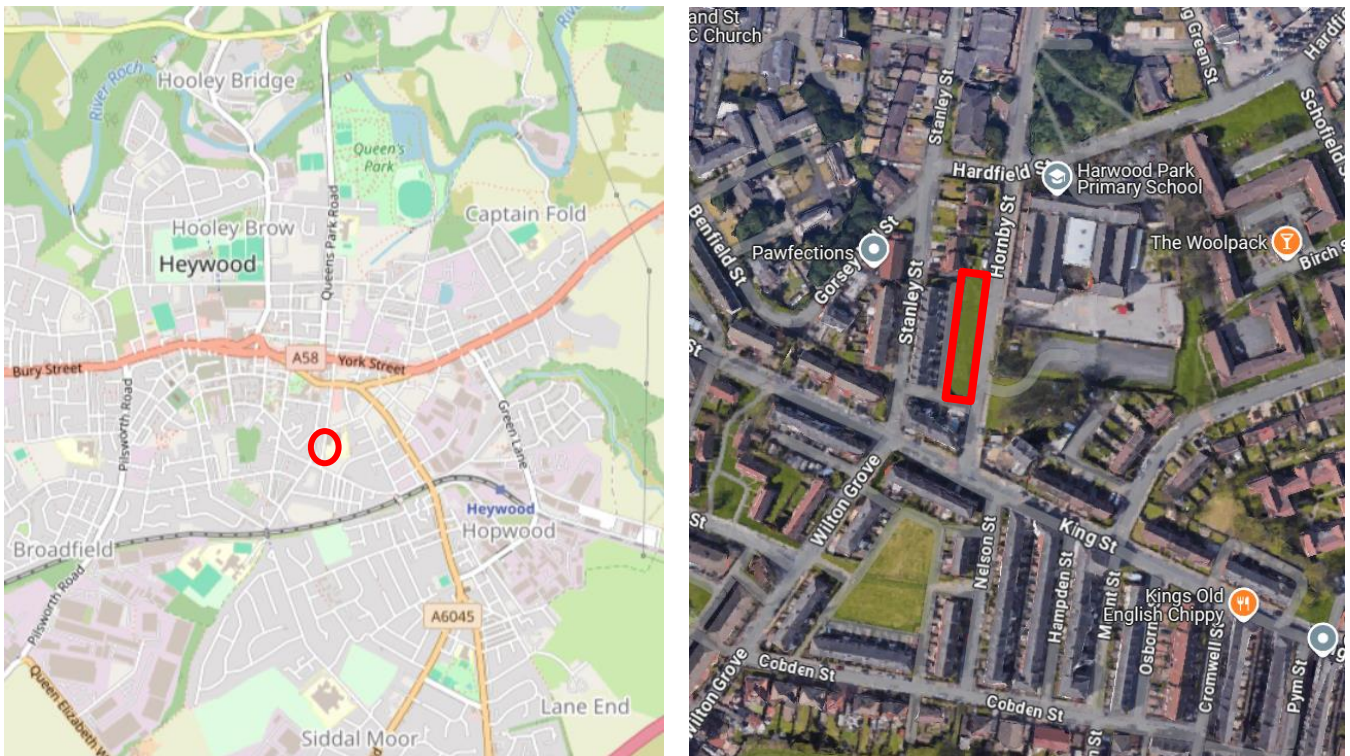


Figure 1: Left: Site Location Plan (©OpenStreetMap, 2024). Right: - Aerial photograph of site (Google Earth, 2024) - Approximate Site Location/Boundary Marked in Red

Pile loadings, locations and cut off levels are shown in the drawings provided by j.c Structural Solutions, who are the structural engineers for the project. These drawings provide characteristic axial, lateral loads and moments.

The design has been carried out in accordance with BS EN 1997 and other relevant documents. All loads have been converted into Eurocode design actions and a pile design is based upon these actions.

Piledesigns Limited (PDL) has been appointed by K&B Piling & Groundworks Limited to undertake the detailed 'element' design for the bearing piles only.

2.0 Information Provided

The main documents that have been consulted in preparing these calculations are summarised below. Any subsequent revisions to these documents should be forwarded for review.

2.1 Engineering Documentation

The following relevant engineering documentation relevant for the design is presented in Table 1 below.

Table 1 – Design Documents

Reference	Rev	Dated	Title	Author
T/11/19798	--	26 th Nov. 2024	Structural Calculations for Proposed Pile Loads & Ground Beams	j.c Structural Solutions

2.2 Specification Documentation

No specific project specification has been provided so consequently reference has been made to the Institute of Civil Engineers publication, ICE Specification for Piling and Embedded Retaining Walls, SPERW, Third Edition published 2017. This is an administrative document for good working practice of piling works and the design has been carried out in general accordance with this document.

2.3 Ground Investigation

Table 2 - Ground Investigation Report

Author	Report Name	Reference	Rev./Issue	Date
Soiltechnics Limited	Ground Investigation Report	STW6573-R01	A	August 2024

2.4 Design Scope & Further Information

The design herein is for the bearing piles to the loads provided within the documents referenced above.

- The design has been carried out in general accordance with EC7;
- It is understood that it is proposed to install 220mm and 273mm diameter bottom driven steel tubular piles across the site.
- The loadings arrangements provided indicate that the piles are under compression, lateral loads and moments only and therefore no allowance has been made for tension loads.
- Loads provided by j.c Structural Solutions limited have been provided as unfactored total loads (Safe Working Load - SWL). Therefore for design purposes a dead/live load split of 75 / 25% has been taken to calculate EC7 design actions. Dead/live load split to be confirmed by j.c Structural Solutions.

- j.c Structural Solutions Limited structural calculation specify that all piles to be designed with a minimum of horizontal load of 5 kN and a moment of 5 kN.m. These loads have been assumed to act concurrently and have been taken as fully variable for design purposes.
- All pile loads have been taken as applied at cut off level.
- j.c Structural solutions Structural Calculation advise that all piles to be installed centrally to the ground beams with a positional tolerance of +/- 25mm. Please note this is a tighter construction tolerance requirement than specified within the ICE Specification for Piling and Embedded Retaining Walls which specifies a positional tolerance of +/- 75mm in any direction.
- No piling levels have been provided. For design purposes piling platform level has been assumed to be coincident with borehole commencement and pile cut off has been taken as 1m below piling platform. Piling cut of level to be confirmed by the structural engineer. Piling platform level to be confirmed by the project team.
- All pile positions have been taken as fixed at the head and restrained in two directions by a slab, two ground beams and/or within a pile cap.
- Design only considers the element design of the bottom driven steel tubular piles based on the specified loads provided.

3.0 Ground Conditions

This section describes ground conditions, based upon the available ground information, and provides a ground model for use within the design and comments on the geotechnical parameters taken.

3.1 Ground Investigation Assessment

Information on ground conditions have been taken from the available published geological information and ground investigation reports carried out for the site as summarised in table 2. The investigation contains the records of two rotary boreholes to maximum depth of 30m and five windowless sample boreholes to maximum depth of 5.45m. No borehole commencement levels or coordinates have been provided for the exploratory holes.

These records show that the site is underlain by a thin mantle of topsoil overlying made ground, and a complex sequence of recent superficial deposits comprising of silt and peat and Glacial Drift Deposits comprising of clays, silt with occasional bands of gravel and sand. The superficial deposits are underlain by the mudstone of the Pennine Lower Coal Measures with depth.

Reference was also made to the British Geological Surveys (BGS) GeoIndex Website, which shows the site directly underlain by Glaciofluvial Deposits comprising of sands and gravels. Glacial Till is recorded immediately south of the site and anticipated to underlie the Glaciofluvial Deposits at depth.

The solid geology outcropping beneath the site is recorded as the Pennine Lower Coal measures deposited during the Carboniferous Period. These deposits comprise of interbedded grey mudstone, siltstone and pale grey sandstone with numerous coal seams. An unnamed coal seam is recorded outcropping beneath the northern parts of the site trending northwest/south east.

Published borehole records held by the BGS located immediately north (SD84DE4), west (SD81SE313) and south (SD81SE314) of the site indicate that the immediate surrounding area is underlain by made ground overlying recent superficial deposits comprising of very soft peaty clay and Glacial Drift Deposits comprising of loose and medium dense, medium to coarse sand and sandy silt overlying firm and firm to stiff slightly gravelly clay. Mudstone of the Pennine Lower Coal Measure are recorded at depths between 7.92m and 11m.

Soiltechnics Limited ground investigation reports concludes following a Coal Mining Risk Assessment that “it is not considered mitigation works to be necessary and the risk of coal mining related land instability affecting the development is considered to be low”. Therefore for design purposes no allowance has been made in the design of the bearing piles for the presence of coal mine works beneath the site.

3.2 Geotechnical Assessment

This section details the derivation of geotechnical properties from field and/or laboratory test data, empirical correlation, theoretical conversions and or reference to design codes. The following soil descriptions below have been taken from the site investigation reports.

3.2.1 Topsoil and Made Ground

Topsoil was encountered in all exploratory holes between 0.15m and 0.3m thickness comprising of dark brown slightly sandy clay.

Made Ground was encountered in four of the exploratory holes to a depth between 0.8m and 1.3m below borehole commencement level. Typically made ground was encountered in the northern and south western parts of the site and appears to be absent in the central and southern sections of the site. Made ground was typically described as dark grey sandy gravelly clay to the north and brown sandy gravel to the south. Anthropogenic material comprising of bricks, glass, clinker, coal, quartz, wood, ash and plastic was noted throughout the deposit.

One pocket penetrometer results only has been undertaken in the made ground in WS02 at 0.4m and record an undrained shear strength of 58 kN/m². Given the limited geotechnical testing and variability of the deposit, for design purposes an internal angle of friction, bulk unit weight and young's modulus of 28°, 18 kN/m³ and 10,000 kN/m² respectively has been taken.

3.2.2 Recent Superficial Deposits

Soil horizons interpreted as recent superficial deposits were encountered in three exploratory holes (RBH01, WS01 and WS02 located in the north of site. These deposits were proven to depths between 2.15m and 3.2m and generally comprised peat and soft sandy silts. Locally a medium dense gravelly silty sand was encountered in WS02 between 0.9m and 1.65m. In WS01, peat was encountered beneath the made ground to a depth of 2.7m and described predominantly as a sandy amorphous peat.

Seven standard penetration tests were undertaken in the soils horizons interpreted as recent superficial deposits ranging between 1 and 15. In addition one pocket penetrometer test results was undertaken in WS02 at 0.8m and recorded an undrained shear strength of 50 kN/m².

3.2.3 Glacial Drift Deposits

Glacial Drift Deposits were encountered in all exploratory holes across the site either directly beneath the made ground in the central and southern parts of the site or beneath the recent superficial deposits in the northern parts of the sites. These deposits were generally described as yellowish brown, brown grey sandy silt, brown sandy slightly gravelly clay and very silty fine to medium sand. Locally in RBH101 between 4.0m and 7.0m no recovery was recorded in the exploratory hole log and therefore soil assumed as similar as above.

Twenty three standard penetration tests were undertaken within the Glacial Drift Deposits ranging between 1 and 39 typically increasing between 6m and 7m below borehole commencement level to between 24 and 39. A summary of the standard penetration test results taken from the exploratory holes have been plotted against depth and are presented in Appendices for both the granular and cohesive horizons.

Pocket penetrometer results in the cohesive horizons of the Glacial Drift Deposits range between 0 kN/m² and 225 kN/m² and have been plotted against depth and presented in the Appendices.

3.2.4 Pennine Lower Coal Measures

Pennine Lower Coal Measures were encountered beneath the Glacial Drift Deposits at depth between 7.0m and 8.0m within the rotary boreholes only (RBH101 & RBH102) and were proven to a maximum depth of 30m. These deposits were typically described as weak to medium strong grey and dark grey thinly laminated mudstone with very closely spaced discontinuities. Locally in RBH101 clay infill was noted between 7.0m and 11.2m.

It should be noted however that beneath 11.2m in RBH101 the Pennine Lower Coal Measures was drilled through open hole technique and was observed as a dark grey mudstone. All bedrock in RBH102 was open holed drilled and exhibited similar characteristics to RBH101. No coal or evidence of mine workings were encountered within the exploratory holes.

Four standard penetration tests were undertaken within the Pennine Lower Coal Measures and ranged between 50 for 265mm increasing to 50 for 50mm within 1.5m penetration.

Three Point Load Index tests were undertaken at depths between 9.54m and 10.9m on samples recovered within the mudstone horizons on the Pennine Lower Coal Measures. These test reported IS_{50} results between 0.64 and 1.28 which can be correlated to unconfined compressive strength between 14 MN/m² and 24 MN/m² indicative of a weak mudstone horizon.

For design purposes it is assumed that the pile will penetrate the Pennine Lower Coal Measures up to a minimum of 500mm where it is assumed piles will encounter practicable refusal. An internal angle of friction, bulk unit weight and young's modulus of 28°, 21 kN/m² and 100,000 kN/m² respectively has been taken for this deposit.

3.2.5 Ground Water

Groundwater was encountered during the advancement of the boreholes in four exploratory holes as detailed below: -

RBH101	Strike at 4.0m depth, rising to 3.9m after 20 minutes. Recorded at 3.1m on completion of borehole
RBH102	Strike at 2.8m depth, remaining stable upon completion of borehole
WS02	Strike at 4.5m depth, rising to 1.4m after 20 minutes
WS04	Strike at 2.8m depth, remaining stable upon completion of borehole

Subsequent long term groundwater monitoring ranged between 0.46m and 2.95m in WS01 and WS03 and in WS05 the groundwater levels ranged between 2.95m and 4.0m however the monitoring well was dry for the last three rounds of monitoring.

For design purposes groundwater has been modelled as 1m below piling platform level.

3.3 Ground Model

The geotechnical design data has been analysed and is presented within the appendices. For design purposes a single ground model has been taken which is outlined in the table below. Please note rock head level varies between 7.0m and 8.0m and it is assumed all piles will be driven to form a minimum 0.5m penetration into the Pennine Lower Coal Measures.

Table 3- Ground Profile

Depth (m)			Soil
PPL	-	1.0	Made Ground
1.0	-	3.0	Recent Superficial Deposits
3.0	-	7.0	Glacial Drift Deposits
7.0	-	7.5	Pennine Lower Coal Measures - Mudstone

3.4 Design Parameters

From the above the following design parameters will be adopted.

Table 4- Design Properties

Soil	γ (kN/m ³) ^[1]	Shaft Adhesion (kN/m ²)	Base Resistance (kN/m ²)	Phi, ϕ (°)	E' (kN/m ²)
Made Ground	18	n/a	n/a	28°	10,000
Recent Superficial Deposits	13 ^[2]	n/a	n/a	25°	5,000
Glacial Drift Deposits	18	n/a	n/a	26°	20,000
Pennine Lower Coal Measures - Mudstone	21	100 ^[3]	10,000 ^[4]	28°	100,000

^[1] Bulk unit weights are based on material descriptions and bulk density testing.

^[2] Bulk unit weight of the Recent Superficial Deposit is considered conservative and could be significantly higher in some parts of the site, particularly where no peat is encountered.

^[3] Due to softening and polishing effects the unit shaft resistance of the Pennine Lower Coal Measures have been limited to 100 kN/m²

^[4] Conservative base resistance taken for piles founded into the Pennine Lower Coal Measures

The figures are Service Limit State (SLS) values and have not had any partial factors applied. Please note where no direct testing has been undertaken to determine the specific design value quoted in Table 4- Design Properties, the value has been based upon published correlations, engineering descriptions and engineering judgment.

Should ground conditions differ to that of the ground model and parameters be found during the piling works this should be relayed back to the designers.

4.0 Geotechnical Design Methodology

The design has been carried out in general in accordance with Eurocode (BS EN 1997-1:2004+A1:2013) with reference made to the UK National Annex and Execution Codes. This is an ultimate limit state design approach with partial factors applied to actions (A), materials (M) and resistances (R).

The main approach is to satisfy that the Design Effect of Actions, E_d is less than the Design Resistance, R_d . The Design Effect of Actions is a combination of actions (A) and or materials (M). Whereas the Design Resistance, R_d , is a combination of resistances (R) and or materials (M). Furthermore, elements will need to satisfy Serviceability Limit State (SLS) requirements which relates to settlements at working conditions.

Reference to typical actions (A), materials (M) & resistances (R) arrangements related to specific elements are presented below. Individual partial factors are presented in the table below, which have been taken from the UK National Annex.

Table 5 - Partial factor for GEO/STR Design Situations

Element	Design Approach 1	A1	A2	M1	M2	R1	R4
Axial Design	Combination 1	•		•		•	
	Combination 2		•	•			•
Lateral Design	Combination 1	•		•		•	
	Combination 2		•		•	•	

Table 6 - Partial factors on actions for the structural (STR) and geotechnical (GEO) limit states

Actions (A) [table NA.A1.2(B) in the NA to BS EN 1990]	Notation	A1	A2
Permanent Action (Unfavourable)	$G_{k,unfav}$	1.35	1.00
Permanent Action (Favourable)	$G_{k,fav}$	1.00	1.00
Variable Action (Unfavourable)*	$Q_{k,unfav}$	1.50	1.30
Variable Action (Favourable)	$Q_{k,fav}$	0.00	0.00

* Secondary variable actions are combined with an accompanying variable partial factor, taken from table NA.A1.1

Table 7 - Partial factors for soil parameters for the STR and GEO limit states

Soil factors (M) [table A.NA.4 in the NA to BS EN 1997]	Notation	M1	M2
Effective angle of shearing resistance	$\tan \phi'$	1.00	1.25
Effective cohesion	c'	1.00	1.25
Undrained shear strength	C_u	1.00	1.40

Table 8 - Partial factors for design resistance for the STR and GEO limit states

Resistances (R) [table A.NA.7 and A.NA.8 in the NA to BS EN 1997]	Notation	R1	R4, without explicit verification of SLS	R4, with explicit verification of SLS
Pile Base	γ_{bRe}	1.00	1.7	1.5
Pile Shaft (compression)	γ_{sRe}	1.00	1.5	1.3
Pile Shaft (tension)	γ_{tRe}	1.00	2.0	1.7
Model Factor	Notation	R1	R4, without explicit verification of ULS	R4, with explicit verification of ULS
Model Factor	γ_{mod}	n/a	1.4	1.2

4.1 Axial Design Philosophy

Pile lengths have been determined from the appropriate partial factors as detailed within Tables A.NA.3, A.NA.4 and A.NA.8 and summarised in tables above for the combinations below.

- Combination 1 (DA1-1): A1 + M1 + R1
- Combination 2 (DA1-2): A2 + M1 + R4

4.2 Lateral Design Philosophy

Pile lateral resistance has been calculated from the appropriate partial factors as detailed within Tables A.NA.3 and A.NA.4 and summarised in tables above for the combinations below.

- Combination 1 (DA1-1): A1 + M1 + R1
- Combination 2 (DA1-2): A2 + M2 + R1

4.3 Design Actions

Vertical Design Actions

Loads have not been provided in a format that permits design to the current design standards, EC7. Therefore to calculate a dead/live load split of 75%/25% respectively has been assumed detailed below. Based on this dead live load split the design actions for the SLS & ULS (STR/GEO) vertical conditions are detailed below.

- Permanent Action, Gk = F.rep x 75%
- Variable Action, Qk = F.rep x 25%
- F.rep.min = Gk x 1.0 F.rep.max = [Gk x 1.0] + [Qk.imp x 1.0]
- DA1-1min = Gk x 0.9 DA1-1max = [Gk x 1.35] + [Qk.imp. x 1.5]
- DA1-2min = Gk x 1.0 DA1-2max = [Gk x 1.0] + [Qk.imp x 1.3]

Lateral Design Actions and Moments

For design purposes the horizontal loads and moments has been taken as fully variable with design actions calculated as follows.

$$DA1-1max = Q_{k.imp.max} \times 1.5$$

$$DA1-2max = Q_{k.imp.max} \times 1.3$$

5.0 Geotechnical Design

The bearing piles are detailed within the drawings by j.c. Structural Solutions Limited as referenced within Table 1. The design has been carried out in general accordance with EC7 to the specified loads provided.

It is understood that 220mm and 273mm diameter steel tubular piles will be installed across the site and founded a minimum of 0.5m penetration into the Pennine Lower Coal Measures with an envisaged minimum pile length of 7.5m.

5.1 Axial Pile Actions

Characteristic pile actions have been provided J.C Structural Solutions Limited as a total unfactored safe working loads. Therefore for design purposes a dead/live loads split of 75%/25% has been taken to calculate EC7 design actions. Dead/live load split to be confirmed by j.c Structural Solutions.

Please note pile loads range between 100 kN and 250 kN. A summary of the characteristic design loads along with the calculated design actions for both the 220mm and 273mm diameters piles are presented in the table below.

Table 9 – Summary of Characteristics and Design Actions

Design Case	Pile Dia.	Min. Pile Length (m)	Characteristic Actions			Calculated Design Actions					
			Dead Load (kN)	Live Load (kN)	Wind (kN)	F.Rep Min (kN)	F.Rep Max (kN)	DA1-1 Min (kN)	DA1-1 Max (kN)	DA1-2 Min (kN)	DA1-2 Max (kN)
1 - Min	220	7.5	75	25	--	75	100	68	139	75	108
1 - Max			127.5	42.5	--	128	170	115	236	128	183
2 - Min	273	7.5	135	45	--	135	180	122	250	135	194
2 - Max			187.5	62.5	--	188	250	169	347	188	269

5.2 Axial Pile Resistance

The ultimate design resistance of a bearing pile is calculated from the sum of resistance gained on the pile shaft and the base, as detailed below;

$$R_{d,vert} = \frac{R_{sk}}{\gamma_{sRe} \cdot \gamma_{mod}} + \frac{R_{bk}}{\gamma_{bRe} \cdot \gamma_{mod}}$$

$$F_{rep,max} \leq \frac{R_{sk}}{\gamma_{s.SLS}}$$

$$R_{td} = \frac{R_{sk}}{\gamma_{t.Re} \cdot \gamma_{mod}}$$

For this site it is understood that neither preliminary nor working tests are proposed. Therefore, the piles have been designed to factors that do not require validation by testing. These calculations consider a model factor of 1.4 and partial factors of 1.5 and 1.7 applied to shaft and base resistances respectively.

For design purposes piling platform level has been taken as coincident with borehole commencement level and pile cut off level assumed to be 1.0m below piling platform level.

All piles have been designed to derive their bearing capacity from the shaft resistance within the Glacial Drift Deposits and shaft and base resistance with the Pennine Lower Coal Measures. Positive shaft friction has been ignored within the made ground and recent superficial deposits up to a depth of 3.0m below piling platform level. Pile design will be undertaken as a static check on the envisaged pile length for a minimum pile length of 7.5m.

Unit shaft friction within Glacial Drift Deposits has been calculated using the β method where β for driven piles ranges between 0.3 to 0.5 for silt and between 0.3 to 0.8 for loose sand.

5.2.1 Static Bearing Capacity – Design Case 1

Static calculations for the envisaged pile length of 7.5m based on a 220mm diameter pile.

Shaft Adhesion

PPL - 3.0m Made Ground and Recent Superficial Deposits - Ignored for Vertical Pile Resistance

3.0m – 7.0m Glacial Drift Deposits– β taken as 0.3

$$\begin{aligned}\sigma_v' &= (1.0\text{m} * 18 \text{ kN/m}^3) + [(13 \text{ kN/m}^3 - 9.81 \text{ kN/m}^3) * 2.0] + [((18 \text{ kN/m}^3 - 9.81 \text{ kN/m}^3) * 4.0\text{m})/2] \\ &= 40.8 \text{ kN/m}^2\end{aligned}$$

$$\begin{aligned}R_{sk} &= \beta * \sigma_v' * A_s \\ &= 0.3 * 40.8 \text{ kN/m}^2 * 0.691\text{m}^2 * 4.0\text{m} \\ &= 34\text{kN}\end{aligned}$$

7.0m – 7.5m Pennine Lower Coal Measures

$$\begin{aligned}R_{sk} &= 100 * 0.691\text{m}^2 * 0.5\text{m} \\ &= 34.6 \text{ kN}\end{aligned}$$

End Bearing

At 7.5m Pennine Lower Coal Measures – Base Resistance taken as 10,000 kN/m²

$$\begin{aligned}R_{bk} &= 10,000 \text{ kN/m}^2 * 0.038\text{m}^2 \\ &= 380 \text{ kN}\end{aligned}$$

<u>Ultimate Shaft Resistance</u>	= 34 kN + 34.6 kN	= 68.6 kN
<u>Ultimate Resistance</u>	= 68.6 kN + 380 kN	= 448.6 kN
<u>DA1-2 Design Resistance</u>	= ((68.6 kN/1.5) + (380 kN/1.7))/1.4	= 192 kN > 183 kN

5.2.2 Static Bearing Capacity – Design Case 2

Static calculations for the envisaged pile length of 7.5m based on a 273mm diameter pile

Shaft Adhesion

PPL - 3.0m Made Ground and Recent Superficial Deposits - Ignored for Vertical Pile Resistance

3.0m – 7.0m Glacial Drift Deposits– β taken as 0.3

$$\begin{aligned}\sigma_v' &= (1.0m * 18 \text{ kN/m}^3) + [(13 \text{ kN/m}^3 - 9.81 \text{ kN/m}^3) * 2.0] + [((18 \text{ kN/m}^3 - 9.81 \text{ kN/m}^3) * 4.0m)/2] \\ &= 40.8 \text{ kN/m}^2\end{aligned}$$

$$\begin{aligned}R_{sk} &= \beta * \sigma_v' * A_s \\ &= 0.3 * 40.8 \text{ kN/m}^2 * 0.858\text{m}^2 * 4.0m \\ &= 42 \text{ kN}\end{aligned}$$

7.0m – 7.5m Pennine Lower Coal Measures

$$\begin{aligned}R_{sk} &= 100 * 0.858\text{m}^2 * 0.5m \\ &= 43 \text{ kN}\end{aligned}$$

End Bearing

At 7.5m Pennine Lower Coal Measures – Base Resistance taken as 10,000 kN/m²

$$\begin{aligned}R_{bk} &= 10,000 \text{ kN/m}^2 * 0.058\text{m}^2 \\ &= 585 \text{ kN}\end{aligned}$$

<u>Ultimate Shaft Resistance</u>	= 42 kN + 43 kN	= 85 kN
<u>Ultimate Resiatnce</u>	= 85 kN + 585 kN	= 448.6 kN
<u>DA1-2 Design Resistance</u>	= ((85 kN/1.5) + (585 kN/1.7))/1.4	= 286 kN > 269 kN

5.2.3 Pile length

From the results of the analysis it is apparent the minimum envisaged pile length of 7.5m driven to practical refusal assuming a 0.5m penetration into the Pennine Lower Coal Measures should be satisfactory to accommodate the working loads up to 170 kN and 250 kN for a 220mm and 273mm diameter pile respectively.

Please note practical refusal has been taken as a set of 20mm for 10 blows or less assuming a 2m drop and a 500 kg hammer for the 220mm diameter pile and a 1000kg hammer for the 273mm diameter pile.

Pile penetration records, sets and re-strikes to be undertaken during the installation of the bearings.

5.3 Lateral Assessment

All bearing piles are subjected to horizontal load of 5 kN and a moment of 5 kN.m. For design purposes the horizontal loads have been taken as fully variable and assessed in the same manner as the vertical load to generate actions for design.

As with the vertical capacity the lateral design load cases have been carried out in general accordance with Eurocode (BS EN 1997-1:2004) with reference made to the UK National Annex. The appropriate partial factors as derived for these combinations is indicated in Table 6 & 7.

5.3.1 Geotechnical Lateral Analysis

Analysis of the pile under horizontal load/bending moments has been carried out using the OASYS Limited computer program ALP version 19.3. The program models the interaction between the pile and the surrounding soil, predicts the pressures, horizontal movements, shear forces and the bending moments induced in the pile.

The pile is modelled as a series of elastic beam elements. The soil is modelled as a series of non-interactive, non-linear springs. The soil deflection has been modelled assuming an elastic-plastic behaviour. Two stiffness matrices relating nodal forces to displacements are developed - one represents the pile in bending the other represents the soil.

For the piles at this site, the pile head has been taken as fixed. The method of analysis used has allowed for a nominal rotational stiffness applied at the pile head, taken as 2,000kN.m per radian for a 220mm diameter pile and 4,000kN.m per radian for a 273mm diameter pile.

The assumed soil profile and soil parameters are detailed in the vertical pile calculations.

Coefficients for passive resistance for the various soils have been taken from the data given in the program manual which are based on Tomlinson's coefficients, 1986.

The flexural rigidity (EI) of the pile is calculated as 3437 kN/m² for a 220mm diameter pile and 8306 for a 273mm diameter pile.

This approach allows an assessment of the depth at which the derived moments should be dissipated and therefore allows a determination of reinforcement length.

Details of the ALP analysis carried out are given in the table below. For the analysis, both lateral actions to DA1-1 (STR) and DA1-2 (GEO) have been considered with the worst case considered for shear/moment design. The results of the ALP analysis are given in the appendices and show the maximum derived moment and indicate the depth below the cut-off level the moment can be considered as sensibly dissipated.

Table 10 - Lateral Load Analysis

Lateral Reference	Pile Diameter (mm)	Lateral Load F.Rep (kN)	Moment (kN.m)	Lateral Load DA1-1 / DA1-2 (kN)	Derived Moment (M) (kN.m)	Depth to dissipate below COL (m)
A	220	5	5	7.5	6.4	3.0
				6.5	5.7	3.0
B	273	5	5	7.5	6.9	3.0
				6.5	6.1	3.0

5.4 Pile Heave

The modified plasticity index result indicate that soils underlying the site are a low to medium volume change potential therefore desiccation will be taken over a 2.5m depth below borehole commencement level. In addition taking into account pile cut off level of typically 0.5m below piling platform level, possible uplift forces to be calculated over a 2.0m pile length for desiccation with an average adhesion within the desiccated zone of 15 kN/m².

For 220mm diameter pile

$$\text{Tk.heave.pile} = 15\text{kN/m}^2 * 0.22 * \pi * 2.0\text{m}$$

$$\text{Tk.heave.pile} = 21 \text{ kN}$$

Plus an allowance for voidformer, Tk.heave.voidformer, taken as 20kN. Therefore, the total heave force, Tk.heave.total is as follows.

$$\text{Tk.heave.total} = \text{Tk.heave.pile} + \text{Tk.heave.voidformer}$$

$$\text{Tk.heave.total} = 21 \text{ kN} + 20\text{kN} = 41\text{kN}$$

For design purposes the calculated heave forces will be counteracted taking 90% of the dead load acting on the pile. Minimum dead load for a 220mm diameter pile is 68 kN. Therefore a no net tension force has been calculated and heave can be discounted in the analysis.

For 273mm diameter pile

$$\text{Tk.heave.pile} = 15\text{kN/m}^2 * 0.273 * \pi * 2.0\text{m}$$

$$\text{Tk.heave.pile} = 26 \text{ kN}$$

Plus an allowance for voidformer, Tk.heave.voidformer, taken as 20kN. Therefore, the total heave force, Tk.heave.total is as follows.

$$\text{Tk.heave.total} = \text{Tk.heave.pile} + \text{Tk.heave.voidformer}$$

$$\text{Tk.heave.total} = 26 \text{ kN} + 20 \text{ kN} = 46 \text{ kN}$$

For design purposes the calculated heave forces will be counteracted taking 90% of the dead load acting on the pile. Minimum dead load for a 273mm diameter pile is 122 kN. Therefore a no net tension force has been calculated and heave can be discounted in the analysis.

6.0 Structural Analysis

Pile section design has been carried out on the basis of the reinforced concrete design code BS EN 1992-1-1:2004 (Eurocode 2) using the following parameters;

Pile Diameter, d_{nom}	=	214mm i.e 220mm – 3mm wall thickness on each side 267mm i.e 273mm – 3mm wall thickness on each side
Design Concrete strength, f_{ck}	=	28 N/mm ² { f_{cu} = 35N/mm ² (C28/35)}
Steel f_{yk}	=	500 N/mm ² [high yield] (BS EN 1992-1-1:2004)

The structural design herein is for the pile actions only, and is the minimum reinforcement required. Pile reinforcement may be increased to suite individual piling contractors preferences or due to installation practicalities.

6.1 Axial Structural Analysis

The axial compressive stress of concrete has been checked in accordance with BS EN 1992-1-1:2004 where the value of design compressive strength, f_{cd} , of concrete is defined as:

$$f_{cd} = (\alpha_{cc} \cdot f_{ck}) / (\gamma_c \cdot k_f)$$

Where, α_{cc} = 0.6

γ_c = 1.5

k_f = 1.1

Considering C28/35 grade concrete, the axial compressive resistance for a 220mm and 273mm diameter pile has been calculated as 387 kN and 596 kN respectively. The maximum STR loadings is understood to be 236 kN and 347 kN on the 220mm and 273mm diameter piles respectively and therefore considered satisfactory.

6.2 Primary Pile Reinforcement

The derived maximum bending moments are checked against the ultimate moments obtained using the OASYS - ADCOL program for columns to BS EN 1992-1-1:2004 Eurocode 2. This program calculates the ultimate moment capacity of the pile section with concrete and reinforcement and at specified working loads. We have not reviewed the pile section against crack width.

The pile stresses detailed in table 11 have been reviewed within the ADC programme to allow for utilisation of at least unity on the equivalent derived ultimate moments of the section.

The results are as follows; with each case analysed for specific pile diameter, reinforcement, and axial load. Outputs for the section analysis for bending and shear are presented within the appendices.

Table 11 - Adcol Analysis

ALP Case	Pile Dia (mm)	STR Axial Load (kN)	STR Moment (m) (kN.m)	STR Shear (kN)	Reinforcement	Ultimate moment (Mu) (kN.m)	M/Mu
A	220	68	6.4	7.5	4B12 longitudinal bars	13.25	0.48
		236				14.99	0.43
B	273	122	6.9	7.5	4B12 longitudinal bars	23.65	0.29
		347				28.57	0.24

Shear analysis through the pile sections indicates that no shear links are required therefore provide a nominal helical binder as required. Shear analysis is presented in the Appendices.

6.3 Concrete

C28/35 concrete has been used in the structural analysis and is sufficient for the pile actions. From the site investigation a ACEC class of AC-1s requirement is given. This would equate to a DC-1 concrete.

For the design allow for, C28/35 DC1, with 50mm cover from outside steel face or 47mm cover from inside steel face.

7.0 Summary

The design herein is for the bearing pile element only, issued for approval from the professional team and relevant third-party bodies.

- Design in general accordance with Eurocode (EC7)
- No piling levels have been provided. For design purposes piling platform level has been assumed to be coincident with borehole commencement and pile cut off has been taken as 1m below piling platform. Piling cut off level to be confirmed by the structural engineer. Piling platform level to be confirmed by the project team.
- It is understood that 220mm and 273mm diameter bottom driven steel tubular piles will be installed across site.
- The loading arrangements provided indicate that the piles are under compression, lateral loads and moment only. No allowance has been made for tension loads.
- All loads have been taken as applied at pile cut off level.
- Static design check based on a minimum pile length of 7.5m founded into the Pennine Lower Coal Measures should have sufficient resistance to accommodate the working loads up to 170 kN and 250 kN for the 220mm diameter piles and 273mm diameter pile respectively. Static calculations assume minimum 0.5m penetration into the Pennine Lower Coal Measures.
- Please note all piles are assumed to be driven to practicable refusal taken as a set of 20mm for 10mm or less based on a 500 kg hammer with a drop height of 2.0m for a 220mm diameter pile or a 1000 kg hammer with a drop height of 2.0m for a 273mm diameter pile.
- Pile penetration records, sets and re-strikes to be undertaken during the installation of the bearings.
- Reinforcement to comprise of 4B12 longitudinal bars with nominal helical binder to the full length of the pile.
- C28/35 DC1 concrete and 47mm cover to all piles from inside face of the steel tubular piles.
- If any works proceed on site prior to receiving approval from any warranty provider, approved inspector or insurance provider (e.g. NHBC, Premier Guarantee, LABC) that may impact the final design and/or details the contractor/client are proceeding at their own risk.

APPENDIX A

DESIGNERS RISK ASSESMENT



STATEMENT ON CDM REGULATIONS (2015) AND RESIDUAL RISKS

CDM Regulations (2015)

The Client and Designer for this project are subject to certain duties under the CDM (2015) Regulations. It is the duty of the Designer to ensure that the client is aware of these duties prior to commencing the design. Piledesigns Ltd are responsible for an 'elemental' part of the design only and are not the 'overall' scheme designer. This 'elemental' design has been undertaken on the premise that this duty has been carried out by the scheme designer, and that no separate approach, in respect of this elemental design, by Piledesigns Ltd is required.

Residual Risks – In accordance with the CDM Regulations (2015) any specific residual design risks and construction sequences relevant to this design are given below. As stated in the CDM Regulations (2015), whilst we have assessed the design risks for our works we have only listed the risks we consider significant to the design and which we consider are not likely to be obvious to a competent contractor or other designer. It does not constitute or remove the need for task related risk assessments for the activities carried out in the implementation of the design. Furthermore, it is the responsibility of the client and principal designer to ensure a competent principal contractor is appointed for these works.

The residual risks below should be added to any relevant construction drawing or method statements and copied to relevant designers and contractors on site.

Item No	Risk	Potential Effects	Risk Management / Mitigation
1	Unforeseen ground conditions	Pile performance could be compromised.	Ground conditions encountered during pile construction should be logged and checked against the assumed design profile and any variations from that assumed in the design must be reported immediately to the designer.
2	Coal Mine Workings	Compromised pile performance	Soiltechnics Limited ground investigation reports concludes following a Coal Mining Risk Assessment that "it is not considered mitigation works to be necessary and the risk of coal mining related land instability affecting the development is considered to be low". Therefore for design purposes no allowance has been made in the design of the

Item No	Risk	Potential Effects	Risk Management / Mitigation
			bearing piles for the presence of coal mine works beneath the site.
3	UXO Risk	Injury to site operatives / public and damage to equipment	The UXO hazard screen undertaken by Soiltechnics indicates that bombing may have occurred in the vicinity of the site, therefore a Preliminary Risk Assessment should be undertaken in accordance with Ciria C785 by a competent specialist.
4	Positional Tolerance	Compromised pile performance	j.c Structural solutions Structural Calculation advise that all piles to be installed centrally to the ground beams with a positional tolerance of +/- 25mm. Please note this is a tighter construction tolerance requirement than specified within the ICE Specification for Piling and Embedded Retaining Walls which specifies a positional tolerance of +/- 75mm in any direction. Piling contractor to control positional tolerance on site.
5	Services	Injury to site operatives / public and damage to equipment	No works should be carried out until a permit to work has been provided to the piling contractor by the Principle Contractor. Where it is necessary to carry out works close to any services the main contractor must positively locate (visually) the service, or divert and decommission the service prior to the commencement of any piling works.
6	Working Platform	Rig instability which could make unsafe working conditions for site personnel	Ensure working platform is designed, constructed and maintained in accordance with published guidance or other appropriate best practice. Construct platform according to specification, inspect regularly and maintain to original specification.
7	Obstructions	Unable to achieve proposed design lengths, damage to equipment.	Ensure all known existing obstructions are removed prior to piling works.

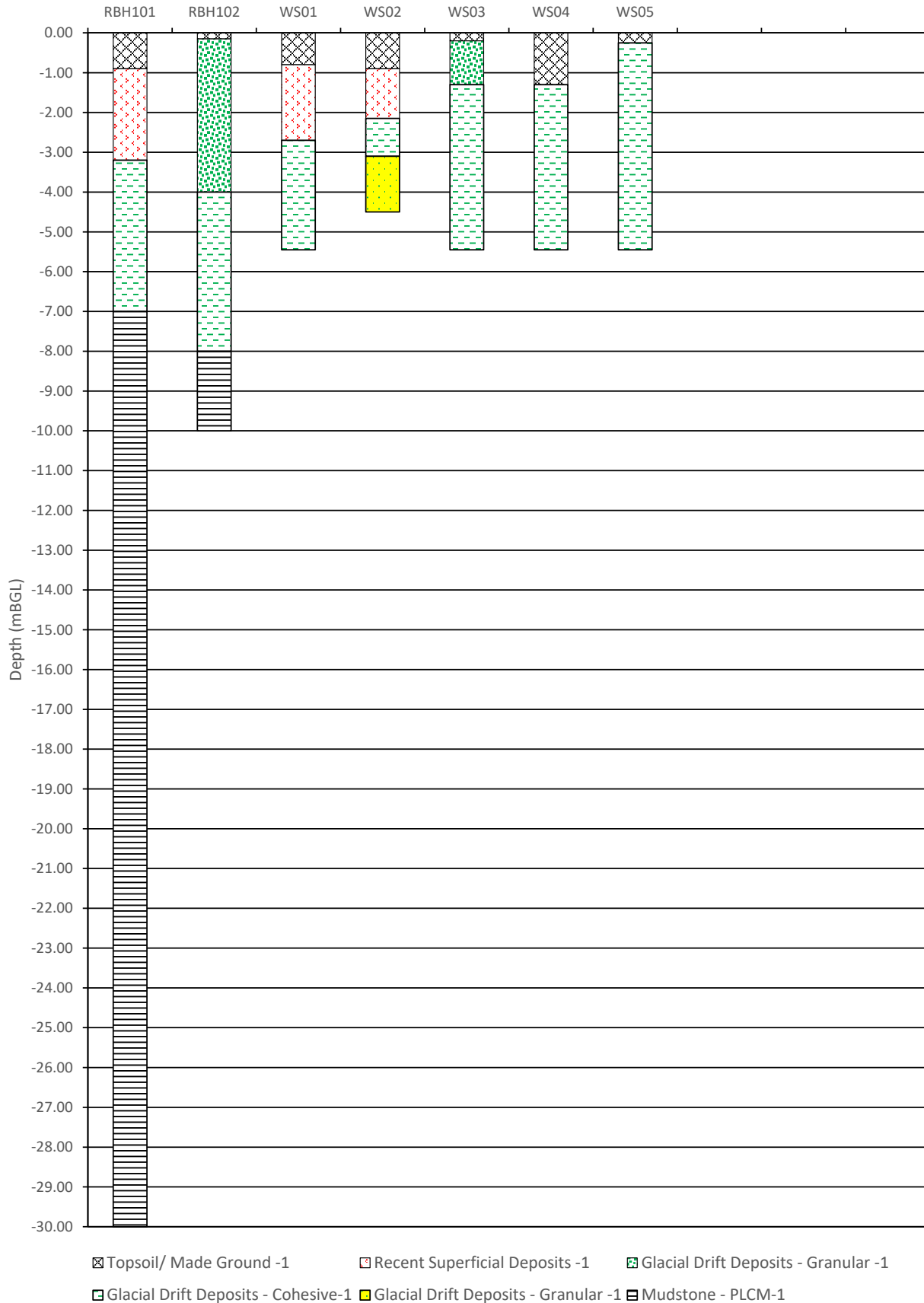
Item No	Risk	Potential Effects	Risk Management / Mitigation
8	Unable to install reinforcement cages	Pile reinforcement does not achieve the required to level.	Reinforcement stated within the design is the minimum required. Reinforcement can be increased in bar diameter and number to increase cage stiffness for pile installation. to ensure adequate rigidity for temporary lifting and also provision of lifting etc.
9	Lifting reinforcement cages	Damage cages, injury to personnel	Ensure all lifting operations are carried out to an agreed method statement / lift plan. All reinforcement cages to have designed lifting points
10	Piling adjacent to neighbouring structures.	Damage to structures	Ensure all piling activities are agreed with the required third parties and the appropriate sign off have been completed before commencement.
11	Non-conformance of concrete	Compromised pile performance	Implement an agreed testing regime of concrete cubes and relay any non-conformances for checking at earliest opportunity
12	Pile Relaxation	Compromised pile performance	Check dynamic sets after installation. If greater than installation sets then re-drive piles.
13	Temporary exposed reinforcement from piles	Injury to site workers	Pile reinforcement to be terminated flush with piling platform level. Where reinforcement extends above piling platform level, these are to be clearly marked and mushroom caps will be required.

APPENDIX B

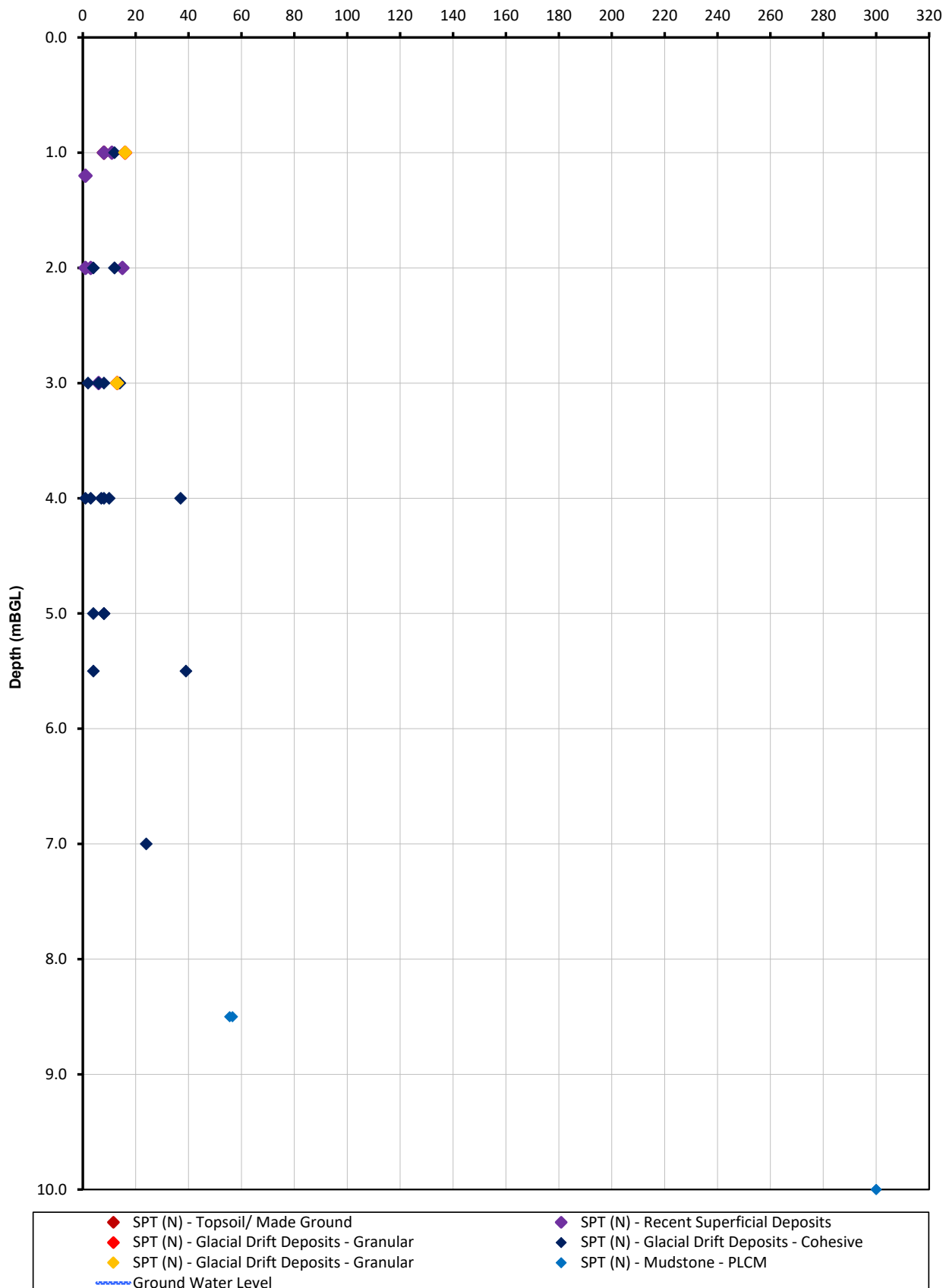
SOILS INFORMATION



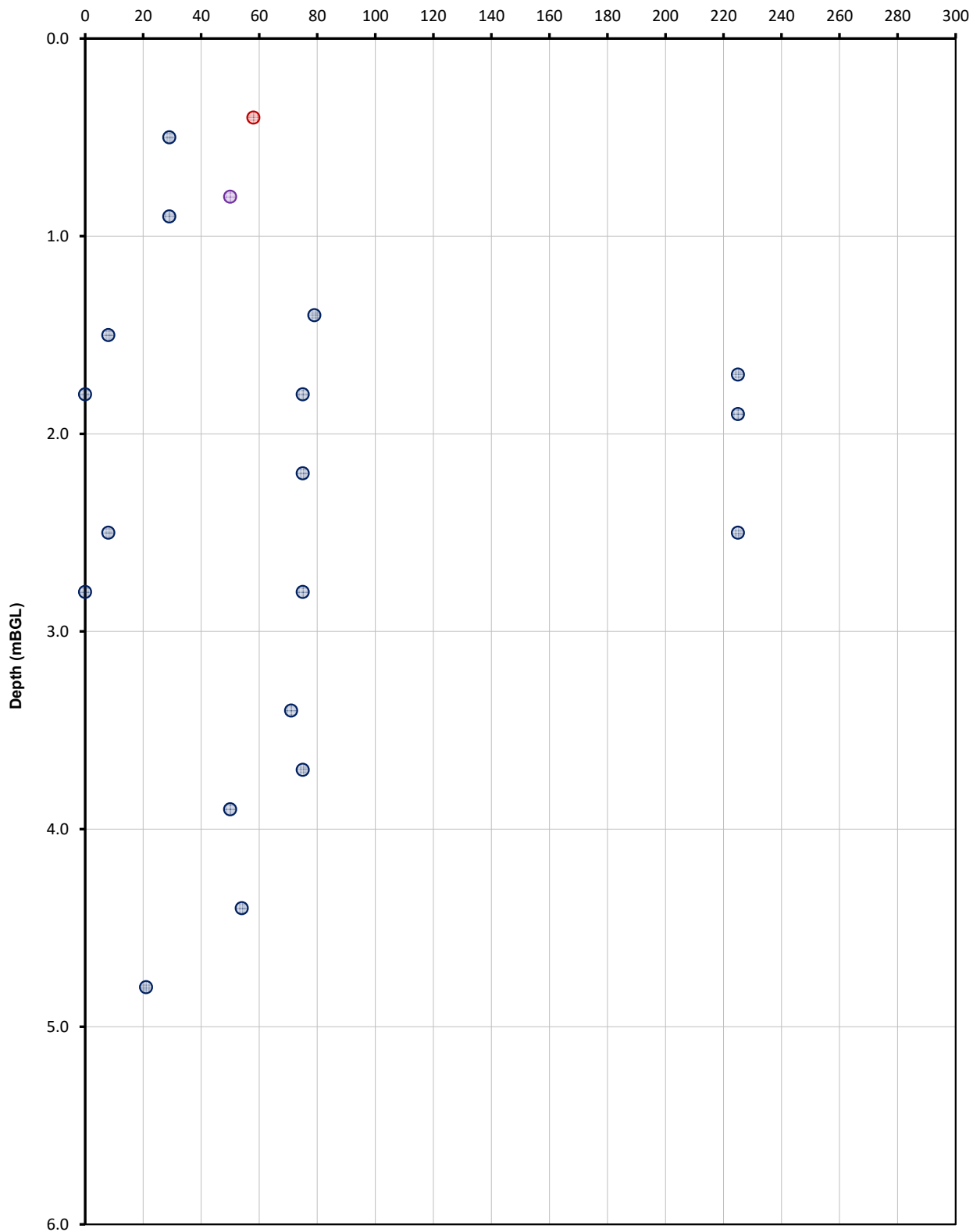
Borehole Profile



All against depth for all boreholes



All against depth for all boreholes



- Undrained Shear Strength - PP (kPa) - Topsoil/ Made Ground
- Undrained Shear Strength - PP (kPa) - Recent Superficial Deposits
- Undrained Shear Strength - PP (kPa) - Glacial Drift Deposits - Granular
- Undrained Shear Strength - PP (kPa) - Glacial Drift Deposits - Cohesive

APPENDIX C

OASYS ALP



Job No.	Sheet No.	Rev.
27819		
Drg. Ref.		
Made by CB	Date	Checked

Notes

Design Case A - 5 kN Lateral + 5 kN.m Moment

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit	Phi	Factored K _q	Factored K _c	c (top)	dc/dz
	[m]	[kN/m ²]	[kN/m ³]	[deg]			[kN/m ²]	[kN/m ² /m]
1	-0.500000	10000.	18.000	28.000	-	-	0.0	0.0
2	-1.000000	5000.0	13.000	25.000	-	-	0.0	0.0
3	-3.000000	20000.	18.000	26.000	-	-	0.0	0.0
4	-7.000000	100000.	21.000	28.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K _q	K _c
1	0.0	4.0943	6.3808
2	0.90909	5.0682	14.451
3	1.8182	5.8658	19.962
4	2.7273	5.1494	19.773
5	3.6364	5.5568	22.006
6	4.5455	5.8999	23.719
7	5.4545	6.1926	25.076
8	6.3636	6.4454	26.177
9	7.2727	6.6658	27.088
10	8.1818	6.8597	27.854
11	9.0909	7.0317	28.508
12	10.000	7.1852	29.072
13	10.909	7.3231	29.564
14	11.818	8.1727	32.508
15	12.727	8.3029	32.946
16	13.636	8.4218	33.338
17	15.000	8.5819	33.853
18	16.364	8.7236	34.297
19	17.727	8.8499	34.685
20	19.091	8.9632	35.025
21	20.455	9.0653	35.326
22	21.818	9.1578	35.595
23	23.182	9.2421	35.837
24	24.545	9.3192	36.055
25	25.909	9.3899	36.252
26	27.273	9.4551	36.433
27	28.182	9.4957	36.544
28	29.091	9.5344	36.649
29	30.000	11.774	44.261
30	30.909	11.823	44.390
31	31.818	11.870	44.513

Sections

Name	Input Type	Description	Material	Class	Effective Width	EI
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Section 1 Explicit Description, Material and Class not applicable [m] [kNm²]
0.22000 3437.0

Pile Properties

Level Section
[m]
-0.50000 Section 1

Pile base at -7.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-0.50000	5.0000	5.0000	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	2000.0

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-0.50000	1	3437.0	0.22000	0.0	0.0
2	-0.70000	1	3437.0	0.22000	0.0	0.0
3	-0.90000	1	3437.0	0.22000	0.0	0.0
4	-1.1000	2	3437.0	0.22000	0.98100	0.0
5	-1.3000	2	3437.0	0.22000	2.9430	0.0
6	-1.5000	2	3437.0	0.22000	4.9050	0.0
7	-1.7000	2	3437.0	0.22000	6.8670	0.0
8	-1.9000	2	3437.0	0.22000	8.8290	0.0
9	-2.1000	2	3437.0	0.22000	10.791	0.0
10	-2.3000	2	3437.0	0.22000	12.753	0.0
11	-2.5000	2	3437.0	0.22000	14.715	0.0
12	-2.7000	2	3437.0	0.22000	16.677	0.0
13	-2.9000	2	3437.0	0.22000	18.639	0.0
14	-3.1000	3	3437.0	0.22000	20.601	0.0
15	-3.3000	3	3437.0	0.22000	22.563	0.0
16	-3.5000	3	3437.0	0.22000	24.525	0.0
17	-3.8000	3	3437.0	0.22000	27.468	0.0
18	-4.1000	3	3437.0	0.22000	30.411	0.0
19	-4.4000	3	3437.0	0.22000	33.354	0.0
20	-4.7000	3	3437.0	0.22000	36.297	0.0
21	-5.0000	3	3437.0	0.22000	39.240	0.0
22	-5.3000	3	3437.0	0.22000	42.183	0.0
23	-5.6000	3	3437.0	0.22000	45.126	0.0
24	-5.9000	3	3437.0	0.22000	48.069	0.0
25	-6.2000	3	3437.0	0.22000	51.012	0.0
26	-6.5000	3	3437.0	0.22000	53.955	0.0
27	-6.7000	3	3437.0	0.22000	55.917	0.0
28	-6.9000	3	3437.0	0.22000	57.879	0.0
29	-7.1000	4	3437.0	0.22000	59.841	0.0
30	-7.3000	4	3437.0	0.22000	61.803	0.0
31	-7.5000	4	3437.0	0.22000	63.765	0.0

Output for load increment 1

Iteration	Max Inc	at node	Disp error	Pressure error
			Disp [mm]	[kN/m ²]
8	1.00	3	0.0008	0.03

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Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-0.50000	-0.91623	534.07E-6	1	-3.6849	0.0	0.0	P
1	-0.50000					-6.4319	-7.5000	
2	-0.70000	-0.98849	202.96E-6	1	-18.246	-4.9481	-7.0175	P
3	-0.90000	-1.0029	-46.486E-6	1	-36.467	-3.6249	-5.8138	
4	-1.1000	-0.97441	-228.29E-6	2	-17.716	-2.6225	-4.6218	
5	-1.3000	-0.91512	-356.33E-6	2	-16.639	-1.7761	-3.8660	
6	-1.5000	-0.83487	-439.39E-6	2	-15.180	-1.0761	-3.1660	
7	-1.7000	-0.74182	-485.63E-6	2	-13.488	-0.50974	-2.5353	
8	-1.9000	-0.64259	-502.38E-6	2	-11.683	-0.062026	-1.9815	
9	-2.1000	-0.54241	-496.09E-6	2	-9.8619	0.28288	-1.5075	
10	-2.3000	-0.44532	-472.27E-6	2	-8.0967	0.54099	-1.1125	
11	-2.5000	-0.35436	-435.53E-6	2	-6.4429	0.72786	-0.79259	
12	-2.7000	-0.27172	-389.59E-6	2	-4.9404	0.85803	-0.54216	
13	-2.9000	-0.19894	-337.35E-6	2	-3.6171	0.94472	-0.35389	
14	-3.1000	-0.13705	-281.01E-6	3	-9.9675	0.99958	-0.055027	
15	-3.3000	-0.086579	-224.06E-6	3	-6.2966	0.96673	0.30278	
16	-3.5000	-0.047195	-170.64E-6	3	-3.4324	0.87847	0.53570	
17	-3.8000	-0.0066125	-102.66E-6	3	-0.48091	0.68944	0.64596	
18	-4.1000	0.016099	-51.642E-6	3	1.1708	0.49089	0.62319	
19	-4.4000	0.026009	-16.983E-6	3	1.8916	0.31553	0.52213	
20	-4.7000	0.027661	3.9579E-6	3	2.0117	0.17761	0.39333	
21	-5.0000	0.024668	14.555E-6	3	1.7941	0.079530	0.26774	
22	-5.3000	0.019633	18.097E-6	3	1.4279	0.016970	0.16141	
23	-5.6000	0.014237	17.368E-6	3	1.0354	-0.017318	0.080126	
24	-5.9000	0.0094262	14.497E-6	3	0.68554	-0.031106	0.023334	
25	-6.2000	0.0056046	10.970E-6	3	0.40761	-0.031319	-0.012740	
26	-6.5000	0.0028153	7.7320E-6	3	0.20475	-0.023462	-0.031821	
27	-6.7000	0.0014495	5.9953E-6	3	0.10542	-0.015971	-0.039771	
28	-6.9000	387.66E-6	4.7018E-6	3	0.028193	-0.0075533	-0.042711	
29	-7.1000	-462.99E-6	3.8855E-6	4	-0.16836	0.0011129	-0.039627	
30	-7.3000	-0.0011960	3.5107E-6	4	-0.43490	0.0082975	-0.026355	
31	-7.5000	-0.0018864	3.4229E-6	4	-0.68597	0.011655	-0.0016961	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-1.0029	0.027661	-502.38E-6	534.07E-6	-6.4319	0.99958	-7.5000	0.64596

RESTRAINT FORCES

No. Node Lateral Moment
force

		[kN]	[kNm]
1	1	0.0	-1.0681

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Notes

Design Case A - 5 kN Lateral + 5 kN.m Moment

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit	Phi	Factored K _q	Factored K _c	c (top)	dc/dz
	[m]	[kN/m ²]	[kN/m ³]	[deg]			[kN/m ²]	[kN/m ² /m]
1	-0.500000	10000.	18.000	28.000	-	-	0.0	0.0
2	-1.000000	5000.0	13.000	25.000	-	-	0.0	0.0
3	-3.000000	20000.	18.000	26.000	-	-	0.0	0.0
4	-7.000000	100000.	21.000	28.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K _q	K _c
1	0.0	2.8504	5.2205
2	0.90909	3.4980	11.279
3	1.8182	4.0016	15.033
4	2.7273	3.5675	15.207
5	3.6364	3.8159	16.675
6	4.5455	4.0206	17.771
7	5.4545	4.1923	18.621
8	6.3636	4.3384	19.299
9	7.2727	4.4642	19.853
10	8.1818	4.5737	20.314
11	9.0909	4.6698	20.704
12	10.000	4.7548	21.037
13	10.909	4.8306	21.326
14	11.818	5.3030	22.868
15	12.727	5.3716	23.113
16	13.636	5.4338	23.331
17	15.000	5.5171	23.615
18	16.364	5.5901	23.859
19	17.727	5.6548	24.071
20	19.091	5.7124	24.256
21	20.455	5.7641	24.419
22	21.818	5.8107	24.564
23	23.182	5.8529	24.694
24	24.545	5.8914	24.811
25	25.909	5.9266	24.917
26	27.273	5.9589	25.013
27	28.182	5.9790	25.073
28	29.091	5.9980	25.129
29	30.000	7.1245	28.705
30	30.909	7.1466	28.767
31	31.818	7.1676	28.826

Sections

Name	Input Type	Description	Material	Class	Effective Width	EI
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Section 1 Explicit Description, Material and Class not applicable [m] [kNm²]
0.22000 3437.0

Pile Properties

Level Section
[m]
-0.50000 Section 1

Pile base at -7.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-0.50000	5.0000	5.0000	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	2000.0

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-0.50000	1	3437.0	0.22000	0.0	0.0
2	-0.70000	1	3437.0	0.22000	0.0	0.0
3	-0.90000	1	3437.0	0.22000	0.0	0.0
4	-1.1000	2	3437.0	0.22000	0.98100	0.0
5	-1.3000	2	3437.0	0.22000	2.9430	0.0
6	-1.5000	2	3437.0	0.22000	4.9050	0.0
7	-1.7000	2	3437.0	0.22000	6.8670	0.0
8	-1.9000	2	3437.0	0.22000	8.8290	0.0
9	-2.1000	2	3437.0	0.22000	10.791	0.0
10	-2.3000	2	3437.0	0.22000	12.753	0.0
11	-2.5000	2	3437.0	0.22000	14.715	0.0
12	-2.7000	2	3437.0	0.22000	16.677	0.0
13	-2.9000	2	3437.0	0.22000	18.639	0.0
14	-3.1000	3	3437.0	0.22000	20.601	0.0
15	-3.3000	3	3437.0	0.22000	22.563	0.0
16	-3.5000	3	3437.0	0.22000	24.525	0.0
17	-3.8000	3	3437.0	0.22000	27.468	0.0
18	-4.1000	3	3437.0	0.22000	30.411	0.0
19	-4.4000	3	3437.0	0.22000	33.354	0.0
20	-4.7000	3	3437.0	0.22000	36.297	0.0
21	-5.0000	3	3437.0	0.22000	39.240	0.0
22	-5.3000	3	3437.0	0.22000	42.183	0.0
23	-5.6000	3	3437.0	0.22000	45.126	0.0
24	-5.9000	3	3437.0	0.22000	48.069	0.0
25	-6.2000	3	3437.0	0.22000	51.012	0.0
26	-6.5000	3	3437.0	0.22000	53.955	0.0
27	-6.7000	3	3437.0	0.22000	55.917	0.0
28	-6.9000	3	3437.0	0.22000	57.879	0.0
29	-7.1000	4	3437.0	0.22000	59.841	0.0
30	-7.3000	4	3437.0	0.22000	61.803	0.0
31	-7.5000	4	3437.0	0.22000	63.765	0.0

Output for load increment 1

Iteration	Max Inc	at node	Disp error [mm]	Pressure error [kN/m ²]
12	0.97	3	0.0009	0.03

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Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-0.50000	-0.91296	414.30E-6	1 -2.5654	0.0	0.0	P
1	-0.50000				-5.6714	-6.5000	
2	-0.70000	-0.96532	121.77E-6	1 -12.593	-4.3827	-6.1665	P
3	-0.90000	-0.96646	-99.007E-6	1 -28.812	-3.2048	-5.2556	P
4	-1.1000	-0.92979	-258.65E-6	2 -16.905	-2.2804	-4.2498	
5	-1.3000	-0.86629	-368.87E-6	2 -15.751	-1.5049	-3.5314	
6	-1.5000	-0.78498	-438.02E-6	2 -14.272	-0.86787	-2.8709	
7	-1.7000	-0.69331	-473.80E-6	2 -12.606	-0.35649	-2.2796	
8	-1.9000	-0.59723	-483.09E-6	2 -10.859	0.043963	-1.7634	
9	-2.1000	-0.50144	-471.89E-6	2 -9.1170	0.34886	-1.3239	
10	-2.3000	-0.40950	-445.31E-6	2 -7.4455	0.57353	-0.95953	
11	-2.5000	-0.32406	-407.61E-6	2 -5.8919	0.73267	-0.66611	
12	-2.7000	-0.24697	-362.19E-6	2 -4.4904	0.83997	-0.43770	
13	-2.9000	-0.17952	-311.71E-6	2 -3.2640	0.90775	-0.26710	
14	-3.1000	-0.12249	-258.15E-6	3 -8.9087	0.94681	697.20E-6	
15	-3.3000	-0.076253	-204.65E-6	3 -5.5457	0.90747	0.31869	
16	-3.5000	-0.040386	-154.88E-6	3 -2.9372	0.81933	0.52147	
17	-3.8000	-0.0037444	-92.037E-6	3 -0.27232	0.63866	0.61123	
18	-4.1000	0.016445	-45.277E-6	3 1.1960	0.45259	0.58075	
19	-4.4000	0.024951	-13.805E-6	3 1.8146	0.29021	0.48140	
20	-4.7000	0.025997	4.9806E-6	3 1.8907	0.16375	0.35913	
21	-5.0000	0.022911	14.282E-6	3 1.6662	0.074733	0.24175	
22	-5.3000	0.018069	17.172E-6	3 1.3141	0.018704	0.14340	
23	-5.6000	0.012991	16.227E-6	3 0.94481	-0.011306	0.068855	
24	-5.9000	0.0085207	13.398E-6	3 0.61969	-0.022609	0.017227	
25	-6.2000	0.0050054	10.038E-6	3 0.36403	-0.021642	-0.015236	
26	-6.5000	0.0024662	6.9956E-6	3 0.17936	-0.013468	-0.032181	
27	-6.7000	0.0012356	5.3766E-6	3 0.089861	-0.0060450	-0.039090	
28	-6.9000	287.62E-6	4.1768E-6	3 0.020918	0.0021685	-0.041528	
29	-7.1000	-464.95E-6	3.4244E-6	4 -0.16907	0.010566	-0.038268	
30	-7.3000	-0.0011094	3.0816E-6	4 -0.40343	0.017476	-0.025673	
31	-7.5000	-0.0017151	3.0017E-6	4 -0.62368	0.020835	-0.0030767	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-0.96646	0.025997	-483.09E-6	414.30E-6	-5.6714	0.94681	-6.5000	0.61123

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	-0.82860

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Notes

Design Case B - 5 kN Lateral + 5 kN.m Moment

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit	Phi	Factored K _q	Factored K _c	c (top)	dc/dz
	[m]	[kN/m ²]	wt.	[kN/m ³] [deg]			[kN/m ²]	[kN/m ² /m]
1	-0.500000	10000.	18.000	28.000	-	-	0.0	0.0
2	-1.000000	5000.0	13.000	25.000	-	-	0.0	0.0
3	-3.000000	20000.	18.000	26.000	-	-	0.0	0.0
4	-7.000000	100000.	21.000	28.000	-	-	0.0	0.0

Calculated K_q and K_c Values

Node	Z/D	K _q	K _c
1	0.0	4.0943	6.3808
2	0.73260	4.8946	13.131
3	1.4652	5.5739	18.043
4	2.1978	4.8747	18.131
5	2.9304	5.2469	20.329
6	3.6630	5.5677	22.062
7	4.3956	5.8471	23.465
8	5.1282	6.0926	24.623
9	5.8608	6.3100	25.595
10	6.5934	6.5039	26.423
11	7.3260	6.6778	27.136
12	8.0586	6.8348	27.758
13	8.7912	6.9772	28.303
14	9.5238	7.7816	31.129
15	10.256	7.9176	31.620
16	10.989	8.0427	32.060
17	12.088	8.2126	32.643
18	13.187	8.3643	33.150
19	14.286	8.5005	33.593
20	15.385	8.6236	33.985
21	16.484	8.7353	34.334
22	17.582	8.8372	34.646
23	18.681	8.9304	34.927
24	19.780	9.0161	35.182
25	20.879	9.0950	35.413
26	21.978	9.1681	35.625
27	22.711	9.2139	35.756
28	23.443	9.2574	35.880
29	24.176	11.396	43.236
30	24.908	11.451	43.388
31	25.641	11.503	43.532

Sections

Name	Input Type	Description	Material	Class	Effective Width	EI
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Section 1 Explicit Description, Material and Class not applicable [m] [kNm²]
0.27300 8306.0

Pile Properties

Level Section
[m]
-0.50000 Section 1

Pile base at -7.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-0.50000	5.0000	5.0000	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	4000.0

Geometry and Initial state

Node	Level [m]	Soil EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-0.50000	1 8306.0	0.27300	0.0	0.0
2	-0.70000	1 8306.0	0.27300	0.0	0.0
3	-0.90000	1 8306.0	0.27300	0.0	0.0
4	-1.1000	2 8306.0	0.27300	0.98100	0.0
5	-1.3000	2 8306.0	0.27300	2.9430	0.0
6	-1.5000	2 8306.0	0.27300	4.9050	0.0
7	-1.7000	2 8306.0	0.27300	6.8670	0.0
8	-1.9000	2 8306.0	0.27300	8.8290	0.0
9	-2.1000	2 8306.0	0.27300	10.791	0.0
10	-2.3000	2 8306.0	0.27300	12.753	0.0
11	-2.5000	2 8306.0	0.27300	14.715	0.0
12	-2.7000	2 8306.0	0.27300	16.677	0.0
13	-2.9000	2 8306.0	0.27300	18.639	0.0
14	-3.1000	3 8306.0	0.27300	20.601	0.0
15	-3.3000	3 8306.0	0.27300	22.563	0.0
16	-3.5000	3 8306.0	0.27300	24.525	0.0
17	-3.8000	3 8306.0	0.27300	27.468	0.0
18	-4.1000	3 8306.0	0.27300	30.411	0.0
19	-4.4000	3 8306.0	0.27300	33.354	0.0
20	-4.7000	3 8306.0	0.27300	36.297	0.0
21	-5.0000	3 8306.0	0.27300	39.240	0.0
22	-5.3000	3 8306.0	0.27300	42.183	0.0
23	-5.6000	3 8306.0	0.27300	45.126	0.0
24	-5.9000	3 8306.0	0.27300	48.069	0.0
25	-6.2000	3 8306.0	0.27300	51.012	0.0
26	-6.5000	3 8306.0	0.27300	53.955	0.0
27	-6.7000	3 8306.0	0.27300	55.917	0.0
28	-6.9000	3 8306.0	0.27300	57.879	0.0
29	-7.1000	4 8306.0	0.27300	59.841	0.0
30	-7.3000	4 8306.0	0.27300	61.803	0.0
31	-7.5000	4 8306.0	0.27300	63.765	0.0

Output for load increment 1

Iteration	Max Inc	at node	Disp error [mm]	Pressure error [kN/m ²]
7	0.86	2	0.0006	0.02

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Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-0.50000	-0.84963	144.19E-6	1 -3.6849	0.0	0.0	P
1	-0.50000				-6.9232	-7.5000	
2	-0.70000	-0.86299	-4.6984E-6	1 -17.621	-5.4434	-6.9184	P
3	-0.90000	-0.84997	-120.27E-6	1 -24.908	-4.1559	-5.7573	
4	-1.1000	-0.81673	-208.13E-6	2 -11.967	-3.1404	-4.7507	
5	-1.3000	-0.76825	-273.11E-6	2 -11.256	-2.2556	-4.1167	
6	-1.5000	-0.70880	-318.28E-6	2 -10.385	-1.4938	-3.5259	
7	-1.7000	-0.64207	-346.47E-6	2 -9.4076	-0.84528	-2.9855	
8	-1.9000	-0.57117	-360.29E-6	2 -8.3688	-0.29955	-2.5002	
9	-2.1000	-0.49876	-362.07E-6	2 -7.3078	0.15480	-2.0722	
10	-2.3000	-0.42701	-353.88E-6	2 -6.2566	0.52935	-1.7019	
11	-2.5000	-0.35775	-337.51E-6	2 -5.2417	0.83558	-1.3880	
12	-2.7000	-0.29245	-314.45E-6	2 -4.2850	1.0846	-1.1280	
13	-2.9000	-0.23233	-285.97E-6	2 -3.4041	1.2868	-0.91804	
14	-3.1000	-0.17836	-253.07E-6	3 -10.453	1.4518	-0.53973	
15	-3.3000	-0.13127	-217.58E-6	3 -7.6937	1.5027	-0.044320	
16	-3.5000	-0.091341	-181.88E-6	3 -5.3533	1.4695	0.34840	
17	-3.8000	-0.044429	-131.82E-6	3 -2.6039	1.3102	0.63771	
18	-4.1000	-0.011554	-88.690E-6	3 -0.67716	1.0869	0.77207	
19	-4.4000	0.0096227	-53.935E-6	3 0.56397	0.84694	0.77671	
20	-4.7000	0.021650	-27.610E-6	3 1.2689	0.62086	0.70165	
21	-5.0000	0.026950	-8.9019E-6	3 1.5795	0.42595	0.58501	
22	-5.3000	0.027626	3.4533E-6	3 1.6191	0.26985	0.45403	
23	-5.6000	0.025372	10.875E-6	3 1.4870	0.15353	0.32683	
24	-5.9000	0.021457	14.741E-6	3 1.2576	0.073751	0.21444	
25	-6.2000	0.016761	16.270E-6	3 0.98231	0.024867	0.12272	
26	-6.5000	0.011829	16.455E-6	3 0.69329	119.13E-6	0.058836	
27	-6.7000	0.0085620	16.188E-6	3 0.50180	-0.0069163	0.021478	
28	-6.9000	0.0053613	15.812E-6	3 0.31421	-0.0084720	-799.31E-6	
29	-7.1000	0.0022375	15.433E-6	4 0.65568	-0.0065966	-0.027277	
30	-7.3000	-820.10E-6	15.179E-6	4 -0.24032	0.0024389	-0.038617	
31	-7.5000	-0.0038460	15.105E-6	4 -1.1270	0.0088501	-0.0012881	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-0.86299	0.027626	-362.07E-6	144.19E-6	-6.9232	1.5027	-7.5000	0.77671

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	-0.57676



Heywood - Land off Hornby Street
273mm Dia Bottom Driven Steel Tubular Piles
Lateral Analysis

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Notes

Design Case B - 5 kN Lateral + 5 kN.m Moment

General Data

Number of increments = 1
Increment applied loads only

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Soil Data

Elastic-plastic soils
Factor on soil E value: 0.8000

No.	Level	E	Unit	Phi	Factored Kq	Factored Kc	c (top)	dc/dz
	[m]	[kN/m²]	wt.	[kN/m³] [deg]			[kN/m²]	[kN/m²/m]
1	-0.500000	10000.	18.000	28.000	-	-	0.0	0.0
2	-1.000000	5000.0	13.000	25.000	-	-	0.0	0.0
3	-3.000000	20000.	18.000	26.000	-	-	0.0	0.0
4	-7.000000	100000.	21.000	28.000	-	-	0.0	0.0

Calculated Kq and Kc Values

Node	Z/D	Kq	Kc
1	0.0	2.8504	5.2205
2	0.73260	3.3852	10.336
3	1.4652	3.8200	13.758
4	2.1978	3.3969	14.098
5	2.9304	3.6275	15.577
6	3.6630	3.8224	16.711
7	4.3956	3.9894	17.610
8	5.1282	4.1340	18.339
9	5.8608	4.2604	18.942
10	6.5934	4.3720	19.450
11	7.3260	4.4711	19.883
12	8.0586	4.5597	20.256
13	8.7912	4.6394	20.582
14	9.5238	5.0941	22.089
15	10.256	5.1672	22.368
16	10.989	5.2340	22.617
17	12.088	5.3241	22.944
18	13.187	5.4038	23.226
19	14.286	5.4749	23.472
20	15.385	5.5386	23.688
21	16.484	5.5961	23.879
22	17.582	5.6483	24.050
23	18.681	5.6958	24.203
24	19.780	5.7392	24.341
25	20.879	5.7791	24.466
26	21.978	5.8159	24.580
27	22.711	5.8388	24.651
28	23.443	5.8606	24.718
29	24.176	6.9516	28.207
30	24.908	6.9769	28.281
31	25.641	7.0010	28.351

Sections

Name	Input Type	Description	Material	Class	Effective Width	EI
------	------------	-------------	----------	-------	-----------------	----

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Section 1 Explicit Description, Material and Class not applicable [m] [kNm²]
0.27300 8306.0

Pile Properties

Level Section
[m]
-0.50000 Section 1

Pile base at -7.500000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	-0.50000	5.0000	5.0000	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	4000.0

Geometry and Initial state

Node	Level [m]	Soil EI [kNm ²]	Effective Width [m]	Water Pressure [kN/m ²]	Soil Disp [mm]
1	-0.50000	1 8306.0	0.27300	0.0	0.0
2	-0.70000	1 8306.0	0.27300	0.0	0.0
3	-0.90000	1 8306.0	0.27300	0.0	0.0
4	-1.1000	2 8306.0	0.27300	0.98100	0.0
5	-1.3000	2 8306.0	0.27300	2.9430	0.0
6	-1.5000	2 8306.0	0.27300	4.9050	0.0
7	-1.7000	2 8306.0	0.27300	6.8670	0.0
8	-1.9000	2 8306.0	0.27300	8.8290	0.0
9	-2.1000	2 8306.0	0.27300	10.791	0.0
10	-2.3000	2 8306.0	0.27300	12.753	0.0
11	-2.5000	2 8306.0	0.27300	14.715	0.0
12	-2.7000	2 8306.0	0.27300	16.677	0.0
13	-2.9000	2 8306.0	0.27300	18.639	0.0
14	-3.1000	3 8306.0	0.27300	20.601	0.0
15	-3.3000	3 8306.0	0.27300	22.563	0.0
16	-3.5000	3 8306.0	0.27300	24.525	0.0
17	-3.8000	3 8306.0	0.27300	27.468	0.0
18	-4.1000	3 8306.0	0.27300	30.411	0.0
19	-4.4000	3 8306.0	0.27300	33.354	0.0
20	-4.7000	3 8306.0	0.27300	36.297	0.0
21	-5.0000	3 8306.0	0.27300	39.240	0.0
22	-5.3000	3 8306.0	0.27300	42.183	0.0
23	-5.6000	3 8306.0	0.27300	45.126	0.0
24	-5.9000	3 8306.0	0.27300	48.069	0.0
25	-6.2000	3 8306.0	0.27300	51.012	0.0
26	-6.5000	3 8306.0	0.27300	53.955	0.0
27	-6.7000	3 8306.0	0.27300	55.917	0.0
28	-6.9000	3 8306.0	0.27300	57.879	0.0
29	-7.1000	4 8306.0	0.27300	59.841	0.0
30	-7.3000	4 8306.0	0.27300	61.803	0.0
31	-7.5000	4 8306.0	0.27300	63.765	0.0

Output for load increment 1

Iteration	Max Inc	at node	Disp error [mm]	Pressure error [kN/m ²]
7	0.79	2	0.0006	0.02

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Node	Level [m]	Defl [mm]	Rotation [rad]	Soil Pressure [kN/m ²]	Bending [kNm]	Shear [kN]	
1	-0.50000	-0.77993	108.40E-6	1 -2.5654	0.0	0.0	P
1	-0.50000				-6.0664	-6.5000	
2	-0.70000	-0.78804	-22.193E-6	1 -12.187	-4.7804	-6.0973	P
3	-0.90000	-0.77301	-123.43E-6	1 -22.652	-3.6275	-5.1462	
4	-1.1000	-0.74032	-199.88E-6	2 -10.847	-2.7219	-4.2316	
5	-1.3000	-0.69442	-255.97E-6	2 -10.175	-1.9349	-3.6577	
6	-1.5000	-0.63910	-294.45E-6	2 -9.3642	-1.2589	-3.1243	
7	-1.7000	-0.57764	-317.89E-6	2 -8.4636	-0.68513	-2.6376	
8	-1.9000	-0.51280	-328.63E-6	2 -7.5135	-0.20381	-2.2014	
9	-2.1000	-0.44690	-328.78E-6	2 -6.5479	0.19545	-1.8176	
10	-2.3000	-0.38187	-320.18E-6	2 -5.5951	0.52321	-1.4861	
11	-2.5000	-0.31930	-304.44E-6	2 -4.6784	0.78988	-1.2056	
12	-2.7000	-0.26048	-282.89E-6	2 -3.8166	1.0055	-0.97368	
13	-2.9000	-0.20645	-256.66E-6	2 -3.0250	1.1794	-0.78691	
14	-3.1000	-0.15807	-226.65E-6	3 -9.2640	1.3202	-0.45142	
15	-3.3000	-0.11594	-194.48E-6	3 -6.7949	1.3599	-0.013015	
16	-3.5000	-0.080279	-162.25E-6	3 -4.7050	1.3254	0.33304	
17	-3.8000	-0.038495	-117.21E-6	3 -2.2561	1.1773	0.58599	
18	-4.1000	-0.0093178	-78.536E-6	3 -0.54610	0.97383	0.70074	
19	-4.4000	0.0093873	-47.473E-6	3 0.55017	0.75690	0.70058	
20	-4.7000	0.019927	-24.017E-6	3 1.1679	0.55348	0.63022	
21	-5.0000	0.024482	-7.4057E-6	3 1.4348	0.37876	0.52364	
22	-5.3000	0.024939	3.5158E-6	3 1.4616	0.23930	0.40503	
23	-5.6000	0.022813	10.033E-6	3 1.3370	0.13574	0.29043	
24	-5.9000	0.019236	13.386E-6	3 1.1274	0.065041	0.18951	
25	-6.2000	0.014988	14.671E-6	3 0.87842	0.022038	0.10737	
26	-6.5000	0.010551	14.776E-6	3 0.61839	617.77E-6	0.050298	
27	-6.7000	0.0076202	14.509E-6	3 0.44661	-0.0052213	0.017003	
28	-6.9000	0.0047535	14.153E-6	3 0.27859	-0.0061835	-0.0027949	
29	-7.1000	0.0019585	13.804E-6	4 0.57393	-0.0041034	-0.026069	
30	-7.3000	-775.87E-6	13.573E-6	4 -0.22736	0.0042440	-0.035530	
31	-7.5000	-0.0034815	13.506E-6	4 -1.0202	0.010109	-0.0014713	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min	Max	Min	Max	Min	Max	Min	Max
[mm]	[mm]	[rad]	[rad]	[kNm]	[kNm]	[kN]	[kN]
-0.78804	0.024939	-328.78E-6	108.40E-6	-6.0664	1.3599	-6.5000	0.70074

RESTRAINT FORCES

No.	Node	Lateral force	Moment
		[kN]	[kNm]
1	1	0.0	-0.43359

APPENDIX D

OASYS ADSEC



Job No.	Sheet No.	Rev.
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Title & Specification

Job number 27819
Job title Heywood - Land of Hornby Street
Subtitle 214mm Dia Pile
Calc. heading Structural Analysis
File E:\Craig\Work Info\07. PREVIOUS COMPANIES\08. Piledesigns\01 Projects\01 - Temporary Job Folder\27819 Heywood - Hornby Street\DESIGN\DOCS\27819 Heywood -ADSEC - C0 -4B12.ads
Notes (none)
Code of Practice BS EN 1992-1-1:2004 [United Kingdom]
Bending Axes Biaxial
Number of sections 1
Number of ULS cases 2
Number of SLS cases 0

Analysis Task

Section 1 : Section 1
Analysis type ULS strength
Analysis case(s) 1 : 1
2 : 2
Number of iterations 1000
Limit iteration step Yes
Perturbation factor 50%

Section : Definition

1 : Section 1

Name Section 1
Type Concrete
Material C28/35
Origin Centre
Dimensions
Diameter 214.0mm
Section Area 35970.mm²
Reinforcement Area 452.4mm²
Reinforcement 1.258%

Section : Nodes

1 : Section 1

Node	Y [mm]	Z [mm]
1	0.0	108.4
2	41.48	100.1
3	76.64	76.64
4	100.1	41.48
5	108.4	-4.738E-6
6	100.1	-41.48
7	76.64	-76.64
8	41.48	-100.1

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Node	Y [mm]	Z [mm]
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9	-9.476E-6	-108.4
10	-41.48	-100.1
11	-76.64	-76.64
12	-100.1	-41.48
13	-108.4	1.293E-6
14	-100.1	41.48
15	-76.64	76.64
16	-41.48	100.1

Section : Cover & Links

1 : Section 1

Cover	47.00mm
Link Size	0.0mm
Link Material	500A

Section : Bars

1 : Section 1

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
1	54.00	0.0	12.00	113.1	113.1	Steel	500A			
2	0.0	54.00	12.00	113.1	113.1	Steel	500A			
3	-54.00	0.0	12.00	113.1	113.1	Steel	500A			
4	0.0	-54.00	12.00	113.1	113.1	Steel	500A			

Section : Elastic Properties

1 : Section 1

Effective properties of the section, ignoring reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
Area		35970.mm ²
Second Moments of Area	I _{yy}	102.9E+6mm ⁴
	I _{zz}	102.9E+6mm ⁴
	I _{yz}	0.0mm ⁴
Principal Second Moments of Area	I _{uu}	102.9E+6mm ⁴
	I _{zz}	102.9E+6mm ⁴
	Angle	0.0°
Shear Area Factor	k _y	0.8571
	k _z	0.8571
Torsion Constant		205.9E+6mm ⁴
Section Modulus	Z _y	962100.mm ³
	Z _z	962100.mm ³
Plastic Modulus	Z _{py}	1.633E+6mm ³
	Z _{pz}	1.633E+6mm ³
Radius of Gyration	R _y	53.50mm

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Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress

R_z 53.50mm

Properties of gross section, including reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
EA		1.238E+6kN
EI	EI _{yy}	3437.kNm ²
	EI _{zz}	3437.kNm ²
	EI _{yz}	0.0kNm ²
Principal EI	EI _{uu}	3437.kNm ²
	EI _{zz}	3437.kNm ²
	Angle	45.00°
Maximum compressive force	N _u	705.6kN
Strain at N _{max}		0.0
Moment at ref. pt. for N _{max}	M _{yy}	0.2137kNm
	M _{zz}	22.12E-6kNm

Note: N_{max} is the maximum compressive force which can be carried by the section.
This is calculated by applying a constant strain across the entire section, using ultimate material properties.

Material : Concrete

1 : C28/35

Name		C28/35
Cylinder Strength	f _{ck}	28.00N/mm ²
Tensile Strength	f _{ctm}	2.766N/mm ²
Weight		Normal Weight
Density	ρ	2.400t/m ³
Elastic Modulus	E	32310.N/mm ²
Poisson's Ratio	ν	0.2000
Coeff. Thermal Expansion	α	10.00E-6/°C
Partial γ _C		1.650
Safety Factor		
Maximum Strain		0.003500
Plateau Strain		0.002000
ULS Compression Curve		Parabola rectangle
ULS Tension Curve		No-tension
SLS Compression Curve		FIB Model
SLS Tension Curve		Interpolated

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress

Design strength factor	α_{cc}	0.8500								
Aggregate Size		20.00mm								

Material : Rebar

2 : 500A

Type	Steel rebar	
Strength	f_{yk}	500.0N/mm ²
Elastic Modulus	E	200000.N/mm ²
Hardening Modulus	E_h	0.0N/mm ²
Density	ρ	7.850t/m ³
Poisson's Ratio	ν	0.3000
Coeff. Thermal Expansion	α	12.00E-6/°C
Ductility	Low	
Partial Safety Factor	γ_s	1.150
	γ_{se}	1.000
Maximum Strain	ϵ_{uk}	0.02500
Maximum Strain	ϵ_{ud}	0.02250
Stress/Strain Curve	Elastic-plastic	

Loading

Reference Point

All loading acts through the Reference Point.
All strain planes are defined relative to the Reference Point.

Definition	Geometric Centroid	
Reference Point Coordinates	y	0.0mm
	z	0.0mm

Applied loads

Load Case	N	M_{yy}	M_{zz}	Note
	[kN]	[kNm]	[kNm]	
1	68.00	6.400	0.0	
2	236.0	6.400	0.0	

Section 1 Details

1.26% reinforcement in section 1 (Section 1). Check this against code requirements.

ULS Cases Analysed

Name	Section	Loading	Prestress Factor
------	---------	---------	------------------

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Name	Section	Loading	Prestress Factor
1 1 :		L1	1.000
Section 1			
2 1 :		L2	1.000
Section 1			

Strength Analysis - Loads

Case	N	M _{yy}	M _{zz}	M	θ
	[kN]	[kNm]	[kNm]	[kNm]	[°]
1	68.00	6.400	0.0	6.400	0.0
2	236.0	6.400	0.0	6.400	0.0

Strength Analysis - Summary

Governing conditions are defined as:
 A - reinforcing steel tension strain limit
 B - concrete compression strain limit
 C - concrete pure compression strain limit
 Eurocode 2 Section 6.1
 Effective centroid is reported relative to the reference point.

Case	Eff. Centroid (y)	Eff. Centroid (z)	N [kN]	M [kNm]	M _u [kNm]	M/M _u	Governing Condition	Neutral Axis Angle [°]	Neutral Axis Depth [mm]
1	-156.8E-9	-75.92E-9	68.00	6.400	13.25	0.4828	B: Node 1	0.0	83.65
2	-154.7E-9	-74.90E-9	236.0	6.400	14.99	0.4269	B: Node 1	0.0	116.5

Strength Analysis - Details

Case	Moment Angle [°]	Description	N [kN]	M [kNm]	Warning
	-115.8	Max. compressive strain	693.2	105.5E-9	
	-133.0	Max. tensile strain	-196.7	0.0	
1	0.0	Axial strength at M	587.6	6.598	
		Initial yield	68.00	12.21	
		Balanced yield	149.3	14.93	
		Bending strength at N=0	0.0	11.67	
2	0.0	Axial strength at M	587.6	6.598	
		Initial yield	236.0	16.67	
		Balanced yield	149.3	14.93	
		Bending strength at N=0	0.0	11.67	

Strain Planes at ULS Strength

Related to Reference Point

Case	Strain Plane	ε _{ax} [-]	κ _{yy} [/m]	κ _{zz} [/m]
1	Reinforcement	-0.001035	0.04184	1.070E-9
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	-0.001035	0.04184	1.070E-9
2	Reinforcement	242.3E-6	0.03005	2.797E-9
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	242.3E-6	0.03005	2.797E-9

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Case	Strain Plane	ϵ_{ax} [-]	κ_{yy} [/m]	κ_{zz} [/m]
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Section Material Stresses/Strains at ULS Strength

Case	Point	Coordinates		Strain	Stress	Notes
		y [mm]	z [mm]	[-]	[N/mm ²]	
1	1	0.0	108.4	0.003500	14.42	
1	2	41.48	100.1	0.003155	14.42	
1	3	76.64	76.64	0.002172	14.42	
1	4	100.1	41.48	700.3E-6	8.332	
1	5	108.4	-4.738E-6	-0.001035	0.0	
1	6	100.1	-41.48	-0.002771	0.0	
1	7	76.64	-76.64	-0.004242	0.0	
1	8	41.48	-100.1	-0.005225	0.0	
1	9	-9.476E-6	-108.4	-0.005571	0.0	
1	10	-41.48	-100.1	-0.005225	0.0	
1	11	-76.64	-76.64	-0.004242	0.0	
1	12	-100.1	-41.48	-0.002771	0.0	
1	13	-108.4	1.293E-6	-0.001035	0.0	
1	14	-100.1	41.48	700.3E-6	8.332	
1	15	-76.64	76.64	0.002172	14.42	
1	16	-41.48	100.1	0.003155	14.42	
2	1	0.0	108.4	0.003500	14.42	
2	2	41.48	100.1	0.003252	14.42	
2	3	76.64	76.64	0.002546	14.42	
2	4	100.1	41.48	0.001489	13.48	
2	5	108.4	-4.738E-6	242.3E-6	3.284	
2	6	100.1	-41.48	-0.001004	0.0	
2	7	76.64	-76.64	-0.002061	0.0	
2	8	41.48	-100.1	-0.002767	0.0	
2	9	-9.476E-6	-108.4	-0.003015	0.0	
2	10	-41.48	-100.1	-0.002767	0.0	
2	11	-76.64	-76.64	-0.002061	0.0	
2	12	-100.1	-41.48	-0.001004	0.0	
2	13	-108.4	1.293E-6	242.3E-6	3.284	
2	14	-100.1	41.48	0.001489	13.48	
2	15	-76.64	76.64	0.002546	14.42	
2	16	-41.48	100.1	0.003252	14.42	

Reinforcement Stresses/Strains at ULS Strength

Case	Bar	Coordinates		Strain	Stress	Notes
		y [mm]	z [mm]	[-]	[N/mm ²]	
1	1	54.00	0.0	-0.001035	-207.1	500A
1	2	0.0	54.00	0.001224	244.8	500A
1	3	-54.00	0.0	-0.001035	-207.1	500A
1	4	0.0	-54.00	-0.003295	-434.8	500A
2	1	54.00	0.0	242.3E-6	48.46	500A
2	2	0.0	54.00	0.001865	373.1	500A
2	3	-54.00	0.0	242.3E-6	48.46	500A
2	4	0.0	-54.00	-0.001381	-276.1	500A

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Title & Specification

Job number 27819
Job title Heywood - Land of Hornby Street
Subtitle 267mm Dia Pile
Calc. heading Structural Analysis
File E:\Craig\Work Info\07. PREVIOUS COMPANIES\08. Piledesigns\01 Projects\01 - Temporary Job Folder\27819 Heywood - Hornby Street\DESIGN\DOCS\27819 Heywood -ADSEC - C0 -273mm - 4B12.ads
Notes Design Case B
Code of Practice BS EN 1992-1-1:2004 [United Kingdom]
Bending Axes Biaxial
Number of sections 1
Number of ULS cases 2
Number of SLS cases 0

Analysis Task

Section 1 : Section 1
Analysis type ULS strength
Analysis case(s) 1 : 1
2 : 2
Number of iterations 1000
Limit iteration step Yes
Perturbation factor 50%

Section : Definition

1 : Section 1

Name Section 1
Type Concrete
Material C28/35
Origin Centre
Dimensions
Diameter 267.0mm
Section Area 55990.mm²
Reinforcement Area 452.4mm²
Reinforcement 0.8080%

Section : Nodes

1 : Section 1

Node	Y [mm]	Z [mm]
1	0.0	134.6
2	41.60	128.0
3	79.12	108.9
4	108.9	79.12
5	128.0	41.60
6	134.6	-5.884E-6
7	128.0	-41.60
8	108.9	-79.12

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Node	Y [mm]	Z [mm]
9	79.12	-108.9
10	41.60	-128.0
11	-11.77E-6	-134.6
12	-41.60	-128.0
13	-79.12	-108.9
14	-108.9	-79.12
15	-128.0	-41.60
16	-134.6	1.605E-6
17	-128.0	41.60
18	-108.9	79.12
19	-79.12	108.9
20	-41.60	128.0

Section : Cover & Links

1 : Section 1

Cover 47.00mm
Link Size 0.0mm
Link Material 500A

Section : Bars

1 : Section 1

Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress
	[mm]	[mm]	[mm]	[mm ²]	[mm ²]			[kN]		
1	80.50	0.0	12.00	113.1	113.1	Steel	500A			
2	0.0	80.50	12.00	113.1	113.1	Steel	500A			
3	-80.50	0.0	12.00	113.1	113.1	Steel	500A			
4	0.0	-80.50	12.00	113.1	113.1	Steel	500A			

Section : Elastic Properties

1 : Section 1

Effective properties of the section, ignoring reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
Area		55990.mm ²
Second Moments of Area	I _{yy}	249.5E+6mm ⁴
	I _{zz}	249.5E+6mm ⁴
	I _{yz}	0.0mm ⁴
Principal Second Moments of Area	I _{uu}	249.5E+6mm ⁴
	I _{zz}	249.5E+6mm ⁴
	Angle	0.0°
Shear Area Factor	k _y	0.8571
	k _z	0.8571
Torsion Constant		498.9E+6mm ⁴
Section Modulus	Z _y	1.869E+6mm ³
	Z _z	1.869E+6mm ³

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Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress
Plastic Modulus			Z_{py}		$3.172E+6mm^3$					
			Z_{pz}		$3.172E+6mm^3$					
Radius of Gyration			R_y		66.75mm					
			R_z		66.75mm					

Properties of gross section, including reinforcement.

Geometric Centroid	y	0.0mm
	z	0.0mm
EA		$1.885E+6kN$
EI	EI_{yy}	$8306.kNm^2$
	EI_{zz}	$8306.kNm^2$
	EI_{yz}	$0.0kNm^2$
Principal EI	EI_{uu}	$8306.kNm^2$
	EI_{zz}	$8306.kNm^2$
	Angle	45.00°
Maximum compressive force	N_u	995.2kN
Strain at N_{max}		0.0
Moment at ref. pt. for N_{max}	M_{yy}	0.2221kNm
	M_{zz}	$-329.0E-6kNm$

Note: N_{max} is the maximum compressive force which can be carried by the section. This is calculated by applying a constant strain across the entire section, using ultimate material properties.

Material : Concrete

1 : C28/35

Name		C28/35
Cylinder Strength	f_{ck}	$28.00N/mm^2$
Tensile Strength	f_{ctm}	$2.766N/mm^2$
Weight		Normal Weight
Density	ρ	$2.400t/m^3$
Elastic Modulus	E	$32310.N/mm^2$
Poisson's Ratio	ν	0.2000
Coeff. Thermal Expansion	α	$10.00E-6/^\circ C$
Partial Factor	γ_c	1.650
Safety Factor		
Maximum Strain		0.003500
Plateau Strain		0.002000
ULS Compression Curve		Parabola rectangle
ULS Tension Curve		No-tension
SLS		FIB Model

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Bar	Y	Z	Diameter	Area	Effective Area	Type	Material	Prestress Force	Prestress Strain	Appl. loads
include/exclude										prestress
Compression Curve		Code								
SLS Tension Curve		Interpolated								
Design strength factor	α_{cc}	0.8500								
Aggregate Size		20.00mm								

Material : Rebar

2 : 500A

Type		Steel rebar
Strength	f_{yk}	500.0N/mm ²
Elastic Modulus	E	200000.N/mm ²
Hardening Modulus	E_h	0.0N/mm ²
Density	ρ	7.850t/m ³
Poisson's Ratio	ν	0.3000
Coeff. Thermal Expansion	α	12.00E-6/°C
Ductility		Low
Partial Safety Factor	γ_s	1.150
	γ_{se}	1.000
Maximum Strain	ϵ_{uk}	0.02500
Maximum Strain	ϵ_{ud}	0.02250
Stress/Strain Curve		Elastic-plastic

Loading

Reference Point

All loading acts through the Reference Point.
All strain planes are defined relative to the Reference Point.

Definition		Geometric Centroid
Reference Point Coordinates	y	0.0mm
	z	0.0mm

Applied loads

Load Case	N [kN]	M_{yy} [kNm]	M_{zz} [kNm]	Note
1	122.0	6.900	0.0	
2	347.0	6.900	0.0	

Section 1 Details

0.81% reinforcement in section 1 (Section 1). Check this against code requirements.

ULS Cases Analysed

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Load Case	N	M _{yy}	M _{zz}	Note
	[kN]	[kNm]	[kNm]	
	Name	Section	Loading	Prestress Factor
	1 1 :	Section 1	L1	1.000
	2 1 :	Section 1	L2	1.000

Strength Analysis - Loads

Case	N	M _{yy}	M _{zz}	M	θ
	[kN]	[kNm]	[kNm]	[kNm]	[°]
1	122.0	6.900	0.0	6.900	0.0
2	347.0	6.900	0.0	6.900	0.0

Strength Analysis - Summary

Governing conditions are defined as:
 A - reinforcing steel tension strain limit
 B - concrete compression strain limit
 C - concrete pure compression strain limit
 Eurocode 2 Section 6.1
 Effective centroid is reported relative to the reference point.

Case	Eff. Centroid (y)	Eff. Centroid (z)	N	M	M _u	M/M _u	Governing Condition	Neutral Axis Angle [°]	Neutral Axis Depth [mm]
			[kN]	[kNm]	[kNm]				
1	-33.12E-9	-783.9E-9	122.0	6.900	23.65	0.2917	B: Node 1	0.0	97.66
2	-32.84E-9	-777.3E-9	347.0	6.900	28.57	0.2415	B: Node 1	0.0	142.7

Strength Analysis - Details

Case	Moment Angle [°]	Description	N	M	Warning
			[kN]	[kNm]	
	-177.6	Max. compressive strain	982.0	702.1E-9	
	-149.1	Max. tensile strain	-196.7	0.0	
1	0.0	Axial strength at M	908.1	7.130	
		Initial yield	122.0	20.83	
		Balanced yield	294.7	28.51	
		Bending strength at N=0	0.0	18.12	
2	0.0	Axial strength at M	908.1	7.130	
		Initial yield	347.0	29.66	
		Balanced yield	294.7	28.51	
		Bending strength at N=0	0.0	18.12	

Strain Planes at ULS Strength

Related to Reference Point

Case	Strain Plane	ε _{ax} [-]	κ _{yy} [/m]	κ _{zz} [/m]
1	Reinforcement	-0.001324	0.03584	-63.80E-12
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	-0.001324	0.03584	-63.80E-12
2	Reinforcement	198.3E-6	0.02453	7.612E-12

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Case	Strain Plane	ϵ_{ax} [-]	κ_{yy} [1/m]	κ_{zz} [1/m]
	User Creep/Shrinkage	0.0	0.0	0.0
	Total (Concrete)	198.3E-6	0.02453	7.612E-12

Section Material Stresses/Strains at ULS Strength

Case	Point	Coordinates		Strain	Stress	Notes
		y [mm]	z [mm]	[-]	[N/mm ²]	
1	1	0.0	134.6	0.003500	14.42	
1	2	41.60	128.0	0.003264	14.42	
1	3	79.12	108.9	0.002579	14.42	
1	4	108.9	79.12	0.001511	13.56	
1	5	128.0	41.60	166.7E-6	2.305	
1	6	134.6	-5.884E-6	-0.001324	0.0	
1	7	128.0	-41.60	-0.002815	0.0	
1	8	108.9	-79.12	-0.004159	0.0	
1	9	79.12	-108.9	-0.005227	0.0	
1	10	41.60	-128.0	-0.005912	0.0	
1	11	-11.77E-6	-134.6	-0.006148	0.0	
1	12	-41.60	-128.0	-0.005912	0.0	
1	13	-79.12	-108.9	-0.005227	0.0	
1	14	-108.9	-79.12	-0.004159	0.0	
1	15	-128.0	-41.60	-0.002815	0.0	
1	16	-134.6	1.605E-6	-0.001324	0.0	
1	17	-128.0	41.60	166.7E-6	2.305	
1	18	-108.9	79.12	0.001511	13.56	
1	19	-79.12	108.9	0.002579	14.42	
1	20	-41.60	128.0	0.003264	14.42	
2	1	0.0	134.6	0.003500	14.42	
2	2	41.60	128.0	0.003338	14.42	
2	3	79.12	108.9	0.002869	14.42	
2	4	108.9	79.12	0.002139	14.42	
2	5	128.0	41.60	0.001219	12.22	
2	6	134.6	-5.884E-6	198.3E-6	2.719	
2	7	128.0	-41.60	-821.9E-6	0.0	
2	8	108.9	-79.12	-0.001742	0.0	
2	9	79.12	-108.9	-0.002473	0.0	
2	10	41.60	-128.0	-0.002942	0.0	
2	11	-11.77E-6	-134.6	-0.003103	0.0	
2	12	-41.60	-128.0	-0.002942	0.0	
2	13	-79.12	-108.9	-0.002473	0.0	
2	14	-108.9	-79.12	-0.001742	0.0	
2	15	-128.0	-41.60	-821.9E-6	0.0	
2	16	-134.6	1.605E-6	198.3E-6	2.719	
2	17	-128.0	41.60	0.001219	12.22	
2	18	-108.9	79.12	0.002139	14.42	
2	19	-79.12	108.9	0.002869	14.42	
2	20	-41.60	128.0	0.003338	14.42	

Reinforcement Stresses/Strains at ULS Strength

Case	Bar	Coordinates		Strain	Stress	Notes
		y [mm]	z [mm]	[-]	[N/mm ²]	
1	1	80.50	0.0	-0.001324	-264.8	500A
1	2	0.0	80.50	0.001561	312.2	500A
1	3	-80.50	0.0	-0.001324	-264.8	500A
1	4	0.0	-80.50	-0.004209	-434.8	500A
2	1	80.50	0.0	198.3E-6	39.67	500A
2	2	0.0	80.50	0.002173	434.6	500A
2	3	-80.50	0.0	198.3E-6	39.67	500A
2	4	0.0	-80.50	-0.001776	-355.2	500A

APPENDIX E

SHEAR ANALYSIS



Project	Heywood - Land off Hornby Street	Project No.	27819	Date	09/12/2024
Title	Design Case A - 220mm Dia Pile	By	CB	Check By	DRI
					Page 1

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

<u>Pile section</u>					
pile dia d_{nom}	=	214	mm		
design pile diameter	=	214	mm		
A_c	=	35968	mm ²		
cover c_{nom}	=	48	mm	[4.4.1.3(4)]	$k_2 = 47$ mm [NA.1 4.4.1.3 (4)]
main bar dia	=	12	mm		
no. main bars	=	4	no.		
helical dia.	=	8	mm		
d	=	132	mm		
f_{ck}	=	28	MPa	$\gamma_c = 1.5$ (This is adjusted by $K_f=1.1$ [2.4.2.5 (2)] to give 1.65)	
f_{yk}	=	500	MPa	$\gamma_c = 1.65$	$\alpha_{cc} = 0.85$ [NA.1 3.1.6 (1)]
Ult V_{Ed}	=	7.5	kN	$\gamma_s = 1.15$	
Ult V_{Ed}	=	7.5	kN	SF factor	1
factored action: N_{Ed}	=	68	kN		

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$	=	$[C_{Rd,c}k(100\rho_1f_{ck})^{1/3}+k_1\sigma_{cp}]b_wd$	$CR_{d,c} = 0.18 / \gamma_c$	0.11
with minimum	=	$(v_{min}+k_1\sigma_{cp})b_wd$	$k = 1+(200/d)^{1/2}$	2.00 ≤ 2.0
v_{min}	=	$0.035k^{3/2}f_{ck}^{1/2}$	$\rho_1 = A_{sl}/b_wd$	0.01 ≤ 0.02
		0.5238	$\sigma_{cp} = N_{ed}/A_c$	1.89 $< 0.2f_{cd}$
$V_{Rd,c}$	=	23 kN	$k_1 = 0.15$	[NA.1 6.2.2(1)]
Is $V_{Rd,c} > V_{Ed}$	=>	YES	Action: No shear links needed - provide nominal links as req'd	

Project	Heywood - Land off Hornby Street	Project No.	27819	Date	09/12/2024
Tilte	Design Case B - 273mm Dia Pile	By	CB	Check By	DRI
					Page 1

Shear to EN 1992-1-1:2004 (EC2) Circular Sections (Cast In-situ) using helical reinforcement

<u>Pile section</u>					
pile dia d_{nom}	=	267	mm		
design pile diameter	=	267	mm		
A_c	=	55990	mm ²		
cover c_{nom}	=	48	mm	[4.4.1.3(4)]	$k_2 = 47$ mm [NA.1 4.4.1.3 (4)]
main bar dia	=	12	mm		
no. main bars	=	4	no.		
helical dia.	=	8	mm		
d	=	175	mm		
f_{ck}	=	28	MPa	$\gamma_c = 1.5$ (This is adjusted by $K_f=1.1$ [2.4.2.5 (2)] to give 1.65)	
f_{yk}	=	500	MPa	$\gamma_c = 1.65$	$\alpha_{cc} = 0.85$ [NA.1 3.1.6 (1)]
Ult V_{Ed}	=	7.5	kN	$\gamma_s = 1.15$	
Ult V_{Ed}	=	7.5	kN	SF factor	1
factored action: N_{Ed}	=	122	kN		

Check requirement for shear reinforcement [6.2.2]

$V_{Rd,c}$	=	$[C_{Rd,c}k(100\rho_1f_{ck})^{1/3}+k_1\sigma_{cp}]b_wd$	$CR_{d,c} = 0.18 / \gamma_c$	0.11
with minimum	=	$(v_{min}+k_1\sigma_{cp})b_wd$	$k = 1+(200/d)^{1/2}$	2.00 ≤ 2.0
v_{min}	=	$0.035k^{3/2}f_{ck}^{1/2}$	$\rho_1 = A_{sl}/b_wd$	0 ≤ 0.02
		0.5238	$\sigma_{cp} = N_{ed}/A_c$	2.18 $< 0.2f_{cd}$
$V_{Rd,c}$	=	40 kN	$k_1 = 0.15$	[NA.1 6.2.2(1)]
Is $V_{Rd,c} > V_{Ed}$	=>	YES	Action: No shear links needed - provide nominal links as req'd	

END OF CALCULATIONS



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Appendix C Piling Method Statement

Method Statement

This method statement is to be read in conjunction with the attached risk assessments and the K&B Piling & Groundwork's Ltd Piling Health and Safety Policy and Procedures Manual.

Description of the Task/Activity:	Pile Foundation				
Project Name:	Hornby Street - Heywood				
Site Address/ Location:	Hornby Street - Heywood	Start Date/Time:	TBC		
		Finish Date/Time:	TBC		
Personnel involved:	Name	Role/Trade			
	Glen Kitchen	Works Supervisor			
	Joe Walton	Rig Operative/Welder			
	Mathew Dawson	Labourer			
	Jay Snape	Rig Operative			
	Glenn Ashton	Welder			
	Rick Barden	Rig Operative			
Works Supervisor:	Glen Kitchen	Role:	Works Supervisor	Tel:	07508665627
Key Plant and Tools Required:	• Power Tools • Hand Tools • Wheelbarrow • Lifting Slings/Chains • 110v Transformer • Grundomat 130 • Cobra D500 Drop hammer Piling Rig • Petrol-powered Cut-off Saws • Gen Set Welder				
Key Materials Required:	• Concrete • Piling Tube • Steel Reinforcement • Shuttering				
Other Essential Equipment:	First Aid Kit				
Specific Identified Residual Hazards:	Please refer to the attached risk assessments. However, the key hazards are: • Manual handling • Slips, trips and falls • Piling trench collapse • Underground services • Noise and vibration				

**Specific Staff
Training
Requirements:**

A competent and experienced site manager/foreman (ie: 10+ years relevant experience) will be appointed to manage and oversee all site operations, he will co-ordinate all aspects of the works including on-site health and safety.

All staff are to receive information and instruction on the content of this method statement and the attached risk assessments. All staff are to receive a site safety induction prior to the commencement of works.

All staff are to receive training on safe excavation techniques and general construction safety awareness training.

Only persons who are competent and have received specific accredited training in the changing and mounting of abrasive wheels shall be permitted to mount, replace or use any abrasive wheel/disc cutter.

Only trained competent operatives shall be permitted to use and operate excavators, dumpers or other plant and equipment. Operators should hold a relevant certificate of competence such as CPCS to demonstrate that they are suitably qualified to operate such machinery.

A record of all staff training shall be maintained and will be available on request.

Sequence of Operations:**Preparatory Phase:****Establish Equipment on Site:**

This step involves bringing in and setting up all the necessary equipment required for the pile installation process. This equipment may include pile drivers and other machinery. It's crucial to ensure that all equipment is in good working order to avoid delays or issues during the installation.

Mark out Pile Locations:

Pile locations are marked out on the construction site based on the engineer's calculations and design. These markings help guide the installation process, ensuring the piles are placed in the correct positions and depths.

Pile Installation phase of steel cased mini piles:**Drive Piles:**

Mini Bottom-Driven Piling is efficient and suitable for most ground conditions. A closed-ended thin-walled steel tube is driven in lengths of between 2m and 6m using an internal drop hammer on to a dry concrete plug. The tubes are joined by a full but non-structural fillet weld as the installation proceeds until the pile is driven to a predetermined set or design length criteria. Once the required depth is reached the tube is filled with high slump concrete or grout and a single bar or cage is inserted.

In this phase, the pile installation process commences. Steel-cased driven mini piles are carefully installed into the ground to the specified depths, following the engineer's guidance. This method uses specialised equipment to drive the piles into the soil or bedrock, ensuring minimal vibration and disturbance to the surrounding area.

Cut Piles to Height:

After the piles are driven into the ground, they may extend above the ground level. In this step, the piles are cut to the predetermined height, aligning them with the project's design requirements.

Install Ground Beams:

Ground beams are structural components that connect the piles and provide stability to the foundation. They are positioned and securely installed, connecting the tops of the piles. Ground beams play a vital role in distributing the load from the structure to the piles.

Sequence of Operations:	Set Level for Concrete: Ensuring the site is level is critical for the overall stability and integrity of the structure. This step involves making sure that the tops of the piles and ground beams are level, creating a solid foundation for the concrete. Concrete Pour: With the site prepared and the ground beams in place, the concrete pour begins. This step involves pouring concrete into the area between the ground beams, creating the foundation for the structure. The concrete should meet project specifications for strength and quality. Site Demobilisation Phase: Return to Original Starting Position: Once the concrete has set and cured sufficiently, the site is restored to its original condition. This may involve backfilling around the foundation, cleaning up the work area, and ensuring that the site is safe and secure for future construction phases. Equipment Removal: After the completion of the pile installation and concrete pour, all equipment used in the process is safely removed from the site. This includes cranes, pile drivers, and any other machinery brought in for the project.
--------------------------------	---

Temporary Supports and Props needed to facilitate the works:	As discussed above.								
Method of Access and Egress to the work area:	There are no specific access restrictions to the site, though the working area is located within a secure site compound to prevent unauthorised access.								
Fall Protection Measures:	N/A								
Hazardous Substances:									
	Highly Flammable	Oxidiser	Explosive	Toxic/ Very Toxic	Corrosive	Harmful / Irritant	Longer Term Health Hazard	Gas Under Pressure	Dangerous to the Environm't
	Yes	No	No	No	Yes	Yes	No	No	No

SWL's:	Not Applicable – however care must be taken not to overload the sides of the trench.						
Required Personnel Protective Equip.:	 Safety Boots	 Hard Hats	 Safety Gloves	 Hearing Protection	 Respiratory Protection	 Eye Protection	Other: 1. Hi-Viz 2. Coveralls 3.
	Yes Required at all times	Yes Required at all times	Yes When handling rough cut timber	Yes When using power tools	Yes When using angle grinders	Yes When using power tools	
Emergency Procedures:	Call 999 and advise the appropriate emergency services Isolate any plant, machinery or other equipment. Do <u>NOT</u> move the injured person unless it is absolutely necessary and they are in danger by remaining where they are. Keep the injured person warm and dry. Inform the site manager and head office.						
 First Aid Facilities:	Name of On-Site First Aider:	Glen Kitchen					
	First Aid Box Location:	A first aid box is available within each of the company's vehicles.					
	Location of Nearest Hospital:	If attendance at hospital is required dial 999 immediately					

Other Information & Comments:

All plant, machinery, tools and equipment will be inspected on each occasion before it is used and in accordance with the manufacturers and statutory requirements. If any defects are identified, the equipment shall be taken out of use and the company's Managing Director informed at once.

K&B Piling & Groundwork's Ltd Pilling are very aware of the potential health hazards presented by hand arm vibration (HAV) and whole body vibration (WBV), notwithstanding this, the use of tools such as angle grinders and concrete pokers will be required at times and to reduce the effects of HAV, a limit of 10 minutes (max.) will be placed on the usage of such tools for each individual, there must then be a break of at least 40 minutes before the tool, or another similar tool is used again.

The use of low vibration tools will be utilised where possible, only low vibration models will be purchased and when tools are being hired, consideration is to be given to lower vibration models.

As with vibration, low noise tools will be selected where appropriate, consideration has been given to the selection of appropriate tools in this method statement and quieter methods of working are selected where appropriate.

All work will be undertaken by qualified competent persons with experience of the type of work described above, and in all cases in full accordance with safety procedures specified in the company's Health and Safety Policy.

Reviewed by: Karl Barden

Position: Director

Date: 17.10.24

Method Statement Briefing Record

Briefing delivered by:

Position:

Date:

We (the undersigned) have read and understood the attached method statement and will comply with the specified requirements and control measures. If the work activity changes or deviates from that originally envisaged, we will seek further advice and request an amended method statement.

Name (Print)	Signature	Date

Point of Work Risk Assessment

Description: Pilling

Additional Point of Work Hazards Not Previously Identified

(To be completed on site)

HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity. Score:	Probable 3	Occasional 2	Remote 1	Catastrophic 5	Critical 4	Serious 3	Marginal 2	Negligible 1	Likelihood x Severity
1										
2										
3										
4										
5										
Risk Assessment Scores:		10+ High Risk			5-9 Medium Risk			1-4 Low Risk		

High and medium rated risks must have additional control measures incorporated to reduce the likelihood and/or severity of the identified hazards

Ref.	Additional Control measures
1	
2	
3	
4	
5	

CONSTRUCTION RISK ASSESSMENTS

Project Title:	Hornby Street - Heywood	Risk Assess. No.:	1							
Task/Activity:	Pilling	Project No.:								
		Date Prepared:	17.10.24							
HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity.	Probable	Occasional	Remote	Catastrophic	Critical	Serious	Marginal	Negligible	Likelihood x Severity
	Score:	3	2	1	5	4	3	2	1	
1	Contaminated ground		X			X				8
2	Underground/buried services	X				X				12
3	Confined spaces	X			X					15
4	Collapse of the excavation		X			X				8
5	Undermining of adjacent structures			X		X				4
6	Water ingress/flooding		X				X			6
7	Noise/vibration	X				X				12
8	Toxic/flammable gases		X			X				8
9	Oxygen deficiency		X			X				8
10	Persons/Plant/Materials falling into the excavation		X		X					10
Risk Assessment Scores:		10+ High Risk			5-9 Medium Risk			1-4 Low Risk		

PERSONS AFFECTED					
Operatives	X	Members of Public	X	Site Visitors	X
Other Workers	X	Managers	X	Young Persons	
Others	X				

PPE REQUIREMENTS					
Harness & Lanyard		Hi-Viz Clothing	X	Respiratory Protection	
Hearing Protection	X	Eye Protection	X	Head Protection	X
Gloves	X	Boots	X		

ADDITIONAL CONTROL MEASURES	
Information/Instruction/Training	Managerial Controls
Information: ➤ Geotechnical Data: The geotechnical data of the site, including soil composition, bearing capacity, and groundwater levels, is crucial information. It informs the design and selection of piles, as different soils may require different types of piles or installation methods. ➤ Engineering Plans: Detailed engineering plans and specifications provide information on pile layout, depth, diameter, and other critical design parameters. This information guides the installation process. ➤	➤ Project Management: Effective project management is crucial for successful piling operations. This involves planning, organising, and overseeing the entire process, from the initial site assessment to the completion of the piling work. Project managers are responsible for setting objectives, establishing timelines, and ensuring that resources are allocated efficiently. ➤ Safety and Compliance: Managerial controls also encompass safety management. Safety procedures and guidelines should be established and enforced to protect workers and the environment. This includes ensuring that the piling operations adhere to local, state, and federal regulations. ➤ Budget and Resource Management: Managing the budget and resources is essential for controlling costs

ADDITIONAL CONTROL MEASURES

Information/Instruction/Training

1. **Safety Data:** Information about potential safety hazards and risk assessments is essential. This includes safety data sheets (SDS) for any chemicals used, as well as information on potential hazards related to equipment and machinery.
2. **Environmental Regulations:** Information about local environmental regulations, including erosion control, sediment management, and other environmental requirements, is necessary to ensure compliance during piling operations.
3. **Weather and Environmental Conditions:** Up-to-date information on weather forecasts and environmental conditions, such as rainfall or temperature fluctuations, is important for scheduling and planning operations.

Instructions:

1. **Pile Installation Procedures:** Clear and detailed instructions for pile installation, including the use of specific equipment, methods for driving piles, and quality control measures, are critical for the successful execution of the work.
2. **Safety Instructions:** Instructions for safety procedures, including the proper use of personal protective equipment (PPE), emergency response protocols, and safety guidelines for working around heavy machinery, are essential to protect workers.
3. **Environmental Compliance:** Instructions for adhering to environmental regulations, including procedures for erosion control, spill response, and waste management, ensure that piling operations are environmentally responsible.
4. **Quality Control Guidelines:** Instructions on conducting quality control checks and inspections to ensure that the piles and ground beams meet the required specifications are necessary for maintaining structural integrity.
5. **Change Management:** Instructions for managing changes to the project scope or design, including procedures for documentation, review, and approval, help maintain project integrity.

Training:

1. **Equipment Operation Training:** Training on how to safely and effectively operate piling equipment and machinery is crucial for the safety and efficiency of the work. This training includes understanding the equipment's controls, maintenance, and safety features.
2. **Safety Training:** All workers involved in piling operations should receive comprehensive safety

Managerial Controls

and maintaining project efficiency. Project managers must monitor expenditures, allocate resources effectively, and make adjustments as needed to stay on budget and meet project deadlines.

- **Quality Assurance and Inspections:** Implementing quality control measures is crucial to maintaining the structural integrity of the foundation. Managers are responsible for setting quality standards, conducting inspections, and addressing any deviations from the specifications.
- **Communication and Coordination:** Effective communication and coordination between various teams and stakeholders are vital. Project managers should ensure that information flows smoothly between engineering teams, construction crews, and other relevant parties.

➤

ADDITIONAL CONTROL MEASURES

Information/Instruction/Training	Managerial Controls
training. This training covers hazard recognition, the proper use of PPE, emergency response procedures, and safe work practices. ➤ Environmental Training: Training on environmental best practices and compliance with regulations is essential to ensure that the construction site minimizes its impact on the environment. ➤ Quality Control Training: Personnel responsible for quality control and inspection should receive training on how to perform checks, conduct tests, and document results to ensure that the piling work meets quality standards. ➤ Project-Specific Training: Depending on the complexity of the project, specific training may be needed, such as working on sites with unique challenges, like sensitive ecosystems or challenging soil conditions. ➤ Communication and Coordination Training: Training in effective communication and coordination is essential for project managers, as they need to manage and coordinate various teams and stakeholders.	
Physical Controls	Procedural Controls
➤ Equipment and Machinery: Proper maintenance, inspection, and safety checks of piling equipment and machinery are essential physical controls. Regular maintenance ensures that the equipment operates efficiently and minimises the risk of accidents due to equipment failure. ➤ Safety Barriers and Signage: Physical controls should include safety barriers and signage to protect workers and the public. Construction sites should be clearly marked with safety signs and barriers to prevent unauthorised access and accidents. ➤ Environmental Protections: Physical controls should also address environmental concerns. Implement erosion control measures, sediment barriers, and any other physical barriers necessary to protect the environment during piling operations. ➤ Noise and Vibration Control: Piling operations can generate significant noise and vibrations. Physical controls, such as noise barriers and vibration-damping materials, may be necessary to mitigate their impact on neighbouring properties and structures. ➤ Site Security: Implement physical controls for site security to prevent theft or unauthorised access. This may include fencing, access gates, and surveillance systems to safeguard the construction site and equipment.	➤ Work Procedures: Clearly defined work procedures and protocols should be established for piling operations. This includes step-by-step instructions for tasks like pile installation, concrete pouring, and site preparation. ➤ Safety Procedures: Procedural controls encompass safety protocols and procedures that all workers must follow. This includes guidelines for personal protective equipment (PPE), emergency response, and safe work practices. ➤ Environmental Protocols: Procedures should be in place to address potential environmental impacts, such as spill containment, waste disposal, and adherence to environmental regulations. ➤ Quality Assurance and Testing: Procedures for quality control, testing, and inspections should be established to ensure that the piling work meets the required standards and specifications. ➤ Change Management: Procedures should be in place to manage changes to the project scope, schedule, or design. These procedures ensure that changes are documented, reviewed, and approved as necessary. ➤

HSE & Other Guidance	Comments
➤ HSG 47 Avoiding Danger from Underground Services	➤

Residual Risk Rating Considering the above control measures MEDIUM	Assessment Prepared by: Karl Barden Name: Karl Barden Signature: Karl Barden Date: 17.10.24
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This risk assessment should be read in conjunction with all relevant method statements, safe systems of work and associated risk assessments as detailed on the Risk Assessment Briefing Record

CONSTRUCTION RISK ASSESSMENTS

Project Title:	Pilling	Risk Assess. No.:	2
Task/Activity:	Storage of Materials on Site	Project No.:	
		Date Prepared:	17.10.24

HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity. Score:	Probable 3	Occasional 2	Remote 1	Catastrophic 5	Critical 4	Serious 3	Marginal 2	Negligible 1	Likelihood x Severity
1	Falling materials (as a result of poorly stacked materials)		X			X				8
2	Injury to unauthorised persons such as children		X			X				8
3	Manual handling	X					X			9
4	Mechanical handling		X					X		4
5										
6										
7										
8										
9										
10										

Risk Assessment Scores:	10+ High Risk	5-9 Medium Risk	1-4 Low Risk
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PERSONS AFFECTED					
Operatives	X	Members of Public		Site Visitors	
Other Workers	X	Managers		Young Persons	
Others	X				

PPE REQUIREMENTS					
Harness & Lanyard		Hi-Viz Clothing	X	Respiratory Protection	
Hearing Protection		Eye Protection		Head Protection	X
Gloves	X	Boots	X		

ADDITIONAL CONTROL MEASURES	
Information/Instruction/Training	Managerial Controls
➤ Site operatives should be instructed of the need for good housekeeping standards and in maintaining a tidy well organised storage area ➤ Operatives should be informed that all chemicals are potentially hazardous and should be handled with care – reference should also be made to the appropriate COSHH assessment before use	➤ Ensure adequate supervision is provided and that control measures remain valid for the duration of the work ➤ Sufficient space should be provided for the safe storage of all materials ➤ All areas to be regularly inspected to ensure the stability and safety of such areas

Physical Controls	Procedural Controls
➤ Perishable goods should be stored within lockable containers	➤

Physical Controls	Procedural Controls
➤ Pipes, drums and other similar materials should be securely chocked ➤ Follow manufacturers/suppliers storage recommendations in all cases ➤ Avoid stacking any materials more than 2m high ➤ All chemicals and fuel's shall be stored within bunded areas to reduce the risk of contamination	

HSE & Other Guidance	Comments
➤	➤

Residual Risk Rating Considering the above control measures
LOW

Assessment Prepared by: Karl Barden

Name: Karl Barden

Signature: Karl Barden

Date: 17.10.24

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CONSTRUCTION RISK ASSESSMENTS

Project Title:	Pilling	Risk Assess. No.:	9
Task/Activity:	Other Hand Tools/Equipment	Project No.:	
		Date Prepared:	17.10.24

HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity. Score:	Probable 3	Occasional 2	Remote 1	Catastrophic 5	Critical 4	Serious 3	Marginal 2	Negligible 1	Likelihood x Severity
1	Splintering/shattering tools			X			X			3
2	Sharp blades/edges		X				X			6
3	Manual handling		X				X			6
4	Damaged tools		X					X		4
5	Incorrect tool for the job			X			X			3
6										

Risk Assessment Scores:	10+ High Risk	5-9 Medium Risk	1-4 Low Risk
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PERSONS AFFECTED					
Operatives	X	Members of Public		Site Visitors	
Other Workers	X	Managers		Young Persons	
Others					

PPE REQUIREMENTS					
Harness & Lanyard		Hi-Viz Clothing		Respiratory Protection	
Hearing Protection		Eye Protection	X	Head Protection	X
Gloves	X	Boots	X		

ADDITIONAL CONTROL MEASURES	
Information/Instruction/Training	Managerial Controls
➤ General awareness training required, together with specific training for any unusual tools ➤ Operatives should be trained to clean, store and maintain all tools	➤ Ensure adequate supervision is provided and that control measures remain valid for the duration of the work

Physical Controls	Procedural Controls
➤ Appropriate PPE to be work ➤ Damage tools to be returned to the supervisor ➤ All tools shall be regularly inspected and maintained ➤ Tools should only be used for their intended purpose	➤

HSE & Other Guidance	Comments
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HSE & Other Guidance	Comments
➤	➤

Residual Risk Rating Considering the above control measures LOW
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Assessment Prepared by: Karl Barden

Name: Karl Barden

Signature: Karl Barden

Date: 17.10.24

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CONSTRUCTION RISK ASSESSMENTS

Project Title:	Pilling	Risk Assess. No.:	11
Task/Activity:	Exposure to Noise	Project No.:	
		Date Prepared:	

HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity. Score:	Probable 3	Occasional 2	Remote 1	Catastrophic 5	Critical 4	Serious 3	Marginal 2	Negligible 1	Likelihood x Severity
1	Distracting influence on staff		X					X		4
2	Continual noise below the first action level	X						X		6
3	Loud noises above the first action level	X					X			9
4	Loud noises above the second action level		X			X				8
5										
6										
7										
8										
9										
10										

Risk Assessment Scores:	10+ High Risk	5-9 Medium Risk	1-4 Low Risk
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PERSONS AFFECTED					
Operatives	X	Members of Public	X	Site Visitors	X
Other Workers	X	Managers	X	Young Persons	
Others					

PPE REQUIREMENTS					
Harness & Lanyard		Hi-Viz Clothing		Respiratory Protection	
Hearing Protection	X	Eye Protection		Head Protection	
Gloves		Boots			

ADDITIONAL CONTROL MEASURES	
Information/Instruction/Training ➤ All operatives should be informed of the hazards and instructed on the required safe systems of works and control measures ➤ All operatives to be provided with appropriate PPE and trained in its use and application ➤ Where the risk of hearing damage has been assessed as being high, all operatives should be trained and informed of the risks and irreversible damage that may be caused by exposure to noise ➤ Operatives to be informed of all mandatory hearing protection zones and of the need to ensure the appropriate protection is worn at all times ➤ Where to obtain the appropriate PPE/hearing protection and how to use it correctly	Managerial Controls ➤ Ensure adequate supervision is provided and that control measures remain valid for the duration of the work ➤ Ensure appropriate safety equipment and PPE are made available ➤ Managers to ensure all safeguards are in place and that the appropriate PPE is provided and used ➤ Where employees are regularly exposed to high levels of noise, consider the need for appropriate Health Surveillance measures

Physical Controls	Procedural Controls
➤ Mandatory hearing protection signs to be erected in all areas where noise levels are likely to exceed 85dB(A) ➤ Make use of acoustic enclosures for noisy plant and equipment, or erect acoustic screens and barriers to deaden any noise ➤ Site plant as far away from the working area as is reasonably practicable– ie: generators and compressors etc do not need to be in the immediate vicinity of the works	➤ When selecting and procuring plant, tools and other equipment, consideration will be given to procurement of low noise equipment wherever possible ➤ Where individual operatives are exposed to high levels of noise, limit their exposure to the noise by restricting the duration of their exposure – rotate different the people used so that no one spends an excessive amount of time exposed to the noise ➤ Ensure all plant and machinery is properly maintained and serviced to help reduce the noise caused by poorly maintained and worn equipment ➤ Ensure that where applicable, silencers are fitted to plant and machinery

HSE & Other Guidance	Comments
➤ INDG362 Noise at Work ➤ The Control of Noise at Work Regulations	➤ Most plant, power tools and machinery are likely to generate noise in excess of the second action level (85dB(A)), this therefore means that hearing protection must be provided and used whilst using such equipment

Residual Risk Rating Considering the above control measures
LOW

Assessment Prepared by: Karl Barden

Name: Karl Barden

Signature: Karl Barden

Date: 17.10.24

This risk assessment should be read in conjunction with all relevant method statements, safe systems of work and associated risk assessments as detailed on the Risk Assessment Briefing Record

CONSTRUCTION RISK ASSESSMENTS

Project Title:	Pilling	Risk Assess. No.:	12
Task/Activity:	Exposure to Vibration	Project No.:	
		Date Prepared:	17.10.24

HAZARDS		Likelihood			Severity					Risk Score
Ref.	Key hazards associated with the above task/activity. Score:	Probable 3	Occasional 2	Remote 1	Catastrophic 5	Critical 4	Serious 3	Marginal 2	Negligible 1	Likelihood x Severity
1	Hand arm vibration syndrome from use of power tools, plant and equipment		X				X			6
2	Whole body vibration from operating vehicles, plant and equipment		X				X			6
3										
4										
5										
6										
7										
8										
9										
10										

Risk Assessment Scores:	10+ High Risk	5-9 Medium Risk	1-4 Low Risk
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PERSONS AFFECTED					
Operatives	X	Members of Public		Site Visitors	
Other Workers		Managers		Young Persons	
Others					

PPE REQUIREMENTS					
Harness & Lanyard		Hi-Viz Clothing		Respiratory Protection	
Hearing Protection	X	Eye Protection		Head Protection	
Anti-Vibration Gloves	X	Boots	X		

ADDITIONAL CONTROL MEASURES	
Information/Instruction/Training	Managerial Controls
➤ All operatives should be informed of the hazards and instructed on the required safe systems of works and control measures for the tools being used ➤ All operatives to be provided with appropriate PPE and trained in its use and application ➤ Operatives to receive full training in the use, storage, and general care of PPE, tools and other equipment ➤ Full manual handling training to be provided to all operatives	➤ Ensure adequate supervision is provided and that control measures remain valid for the duration of the work ➤ Ensure appropriate safety equipment and PPE are made available ➤ Select low vibration and low noise models when procuring plant and equipment

Physical Controls	Procedural Controls
➤ Limit duration of exposure to reduce the level of risks from exposure to high noise and vibration levels ➤ Keep hands warm ➤ Only 110v or less tools are to be used ➤ Trailing cables shall be managed to reduce the risk of slips, trips and falls ➤ All tools shall be earthed or double insulated ➤ Temporary and impromptu repairs to power cables shall not be allowed ➤ All tools and cables shall be inspected before use ➤ When not in use, all tools shall be disconnected from its electrical supply ➤ All damaged and defective equipment shall immediately be taken out of use, reported to the supervisor and marked as being defective	➤ A planned preventative maintenance system shall be implemented whereby all equipment shall be regularly inspected, tested and maintained in accordance with manufacturers recommendations ➤ Ensure all tools are properly maintained and lubricated to help reduce the extent of vibration ➤ Ensure correct tool for the job has been selected ➤ Manufacturers vibration monitoring details to be obtained for all tools ➤ Recommended maximum exposure limits/times set by the manufacturer/supplier shall not be exceeded

HSE & Other Guidance	Comments
➤ HSE Guidance Notes – Safe Use of Portable Electrical Equipment ➤ Electricity on Construction Sites ➤ HSE Information Sheet – Maintenance of Portable Electrical Equipment ➤ INDG296 Hand Arm Vibration – Advice for Employees ➤ Control of Vibration at Work Regulations ➤ INDG175 – Control the Risk From Hand-Arm Vibration, Advice for Employers	➤ Due to the nature of our work, the use of hand held power tools is not a regular activity and it is generally only for short durations

Residual Risk Rating Considering the above control measures
LOW

Assessment Prepared by: Karl Barden

Name: Karl Barden

Signature: Karl Barden

Date: 17.10.2024

This risk assessment should be read in conjunction with all relevant method statements, safe systems of work and associated risk assessments as detailed on the Risk Assessment Briefing Record