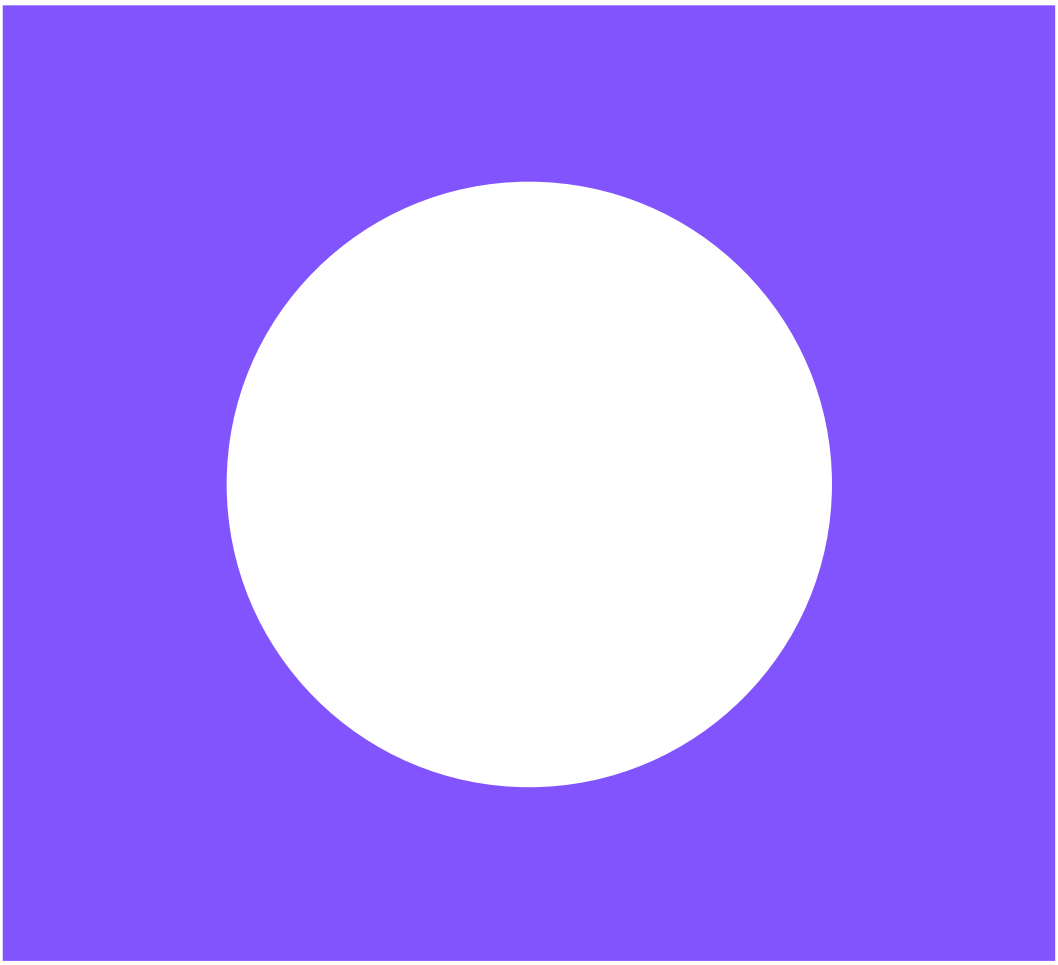
MOTT MACDONALD



Christie Advanced Scanning and Imaging Centre Development

Specification for Piling

January 2026

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Christie Advanced Scanning and Imaging Centre Development

Specification for Piling

January 2026

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Executive summary

The General Specification for piling for the ***Christie Advanced Scanning and Imaging Centre*** project shall be Part B of the Institution of Civil Engineers (ICE) 'Specification for Piling and Embedded Retaining Walls' (*SPERWall*), 3rd Edition, amended and supplemented as indicated in this Project Specification.

The sections of *SPERWall* considered particularly applicable to the project are as follows.

B1	Specification requirements for piling and embedded retaining walls
B3	Bored cast-in-place piles
B4	Piles constructed using continuous flight augers or displacement augers
B15	Integrity testing
B17	Static load testing of piles
B21	General requirements for concrete, mortar, structural grout and steel reinforcement

This Project Specification for piling (which is referenced in accordance with the above-mentioned sections of *SPERWall*) is intended to cover all aspects of the piling works for the project. This document should be read in conjunction with *SPERWall* and the project-specific civil and structural specifications, scopes of work, and drawings, including the piling layout drawings as referenced herein.

This document represents a performance specification for specialist contractor-design of piles (bearing piles), and it summarises the design standards and design criteria; settlement / deformation tolerances for piles; specified working loads; and minimum pile testing requirements for the permanent piling works associated with the foundations of the proposed new healthcare facility.

This document outlines the technical requirements for piling and does not cover any specific contractual or commercial aspects of the piling contract, or deal with any temporary works matters.

The Contractor (piling specialist) is required to execute the piling works in a safe and controlled manner and employ stringent safety control measures, set out in project-specific Risk Assessment and Method Statement (RAMS) to ensure no environmental, health, safety or security incidents or accidents occur. Execution of the piling works is to be undertaken in close proximity to existing healthcare buildings and infrastructure, and cognisance must be taken of this in planning and in the selection of appropriate plant and equipment for installation, testing and monitoring of the works.

Project Specification

B1 Specification Requirements

B1.2 Project Specification

(a) Role of the contract administrator

The role of the contract administrator is as defined in the contract for piing works between the Principal Contractor and the Contractor (specialist piling sub-contractor).

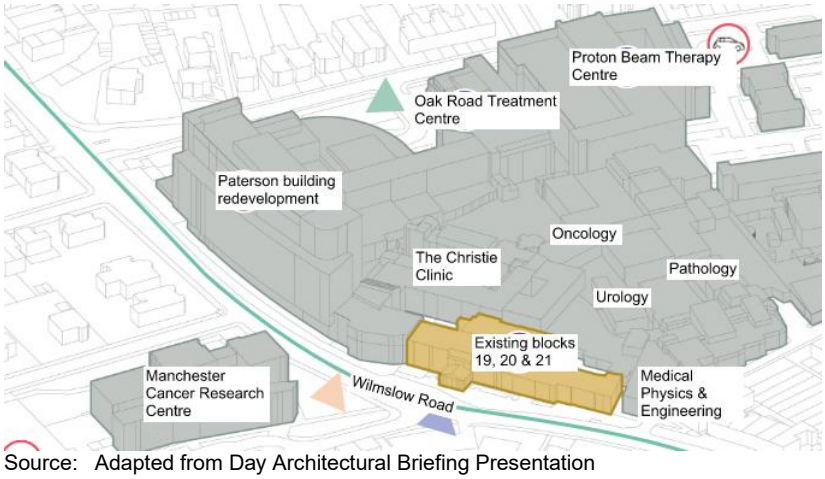
The following terms are used throughout this Project Specification, as deemed applicable to the relevant parties in the piling contract:

- Employer: **IHP (Integrated Health Projects)**
- Principal Contractor: **IHP**
- Foundation Scheme Designer: **Mott MacDonald**
- Contractor (specialist piling sub-contractor): **To be confirmed**

(b) Location and description of the site

The Christie Hospital campus is in Withington, Greater Manchester and is bordered by Wilmslow Road (including a cycle lane) to the East. The development site consists of existing Blocks 19 and 20 which are to be demolished along with the partial demolition of Block 21 and are to be replaced with a new CT department. The site is surrounded on three sides by existing hospital buildings. An access road is present adjacent to the northern boundary of the site, connecting Wilmslow Road with Palatine Road, to the west of the site. The site plan is shown below in Figure 0.1.

Figure 0.1: Site Plan



Source: Adapted from Day Architectural Briefing Presentation

Reference should be made to the project drawings for the layout of the proposed piled structures. Preliminary working platform level for piling operations is as stated on the project drawings.

Access routes to and within the site, for mobilisation and movement of piling plant and apparatus, are to be agreed with the Principal Contractor during the planning stage of the

works. Specific access routes to pile locations, and sequence of pile installation, are to be discussed and agreed prior to movement and set-up.

The Contractor should undertake a site walkover inspection to appreciate the site conditions to inform planning and programming of the proposed piling works.

(c) Nature of the works

Overview

The piling contract refers to piling works as depicted on the project drawings, as detailed in the pile schedules, and as described in this Project Specification and other project documents.

The nature of the piling works comprises the design and construction, including associated testing and reporting of reinforced concrete bearing piles to form part of the sub-structures to the proposed new Christie Advanced Scanning and Imaging Centre. Piles will be utilised to support structural building columns as well as to support reinforced concrete cores located at the north and south corners of the proposed building.

Bearing Piles

Bearing piles shall be designed by the Contractor according to *SPERWall* 'Option 2 – Contractor design of piles'.

Piles are required to support predominantly axial compression loads as well as lateral loads. Piles are utilised in isolated pile groups and piled raft configurations as shown on the project drawings. Permanent bearing piles are to be installed in two phases at the site, as follows:

- **Phase 1:** 450mm diameter piles installed in a restricted access location, as shown on the project drawings, in close proximity to existing hospital building.
- **Phase 2:** 600mm diameter piles installed following demolition of the existing building and basement structure, supporting new structural columns and building cores.

Piles required for support of (temporary) tower crane foundations are to be confirmed and are not currently covered by this Piling Specification.

The trimming of piles to their final cut-off level (COL) and the construction of substructures will be carried out by the Principal Contractor and is not part of the piling contract.

Piling Summary

The proposed locations of individual bearing piles are shown on the piling layout drawings. A general summary of piling is provided below:

Development Item	Quantity (approx.)	Permitted Pile Type *	Nominal Pile Diameter **
Phase 1 - Restricted access piles Early Works	**4 no.** As shown on layout drawings & pile schedule	Bored or Augered pile *SPERWall* Section B3 or B4	**450mm** As shown on layout drawings & pile schedule
Phase 2 - Building columns and cores	**TBC** As shown on layout drawings & pile schedule	Bored or Augered pile *SPERWall* Section B3 or B4	**600mm** As shown on layout drawings & pile schedule
Tower cranes	To be confirmed	Bored or Augered pile *SPERWall* Section B3 or B4	**To be confirmed**

(*) Method of piling to enable consistent socketing / embedment of piles into underlying competent bedrock

(**) Minimum pile diameter to suit substructure designs

The Contractor is responsible for selecting the pile type and piling method to meet the project requirements and to suit the site-specific constraints (including limitations on noise and vibrations from piling), access restrictions, ground and groundwater conditions, and shall take account of all available ground investigation and site information including the following (non-exhaustive) list of ground-related hazards:

- Variable rockhead levels, rock weathering / condition, and rock strength / stiffness characteristics
- Variable and uncertain extents and interface of potentially differing rock types

A bored or augered pile type is favoured by the Foundation Scheme Designer. The method proposed by the Contractor shall provide for reliability of installation in the site-specific ground conditions and for consistency of pile rock socket / embedment. All piles are to be embedded within the underlying Sandstone bedrock, as characterised by project-specific ground investigations. Due to the proximity of existing hospital buildings, the method of piling selected for the works shall limit noise and vibration to levels as agreed with the Principal Contractor.

(d) Working area

The Contractor is required to construct piles at locations shown on the project drawings.

The Contractor shall agree all working areas, including access routes, no-go areas, site compound, and laydown / storage areas, with the Principal Contractor prior to the commencement of site works. The following aspects shall be accounted for by the Contractor in the planning and execution of the piling works:

1. Existing buried utilities/services that must be safeguarded from damage and/or distress from piling and ancillary plant movements.
2. The proximity of existing above-ground buildings and infrastructure and their foundations. Clearance distances between piling rig and adjacent structures and foundations shall be discussed and agreed prior to site works.
3. Working adjacent to existing operational healthcare facilities. Acceptable limits on noise and vibration from piling are to be agreed with the Principal Contractor.

The Contractor shall liaise with the Principal Contractor to ensure that all site constraints are identified and fully understood prior to site works commencing.

(e) Sequence of the works and other works proceeding at the same time

The Contractor shall agree the sequence of pile execution with the Principal Contractor.

It is envisaged that piling will be completed in **two phases** of site works comprising a phase of early works pile installation (Phase 1) within a restricted access location, followed by a phase of piling for the main building foundations (Phase 2). The Phase 2 works will commence following demolition of the existing building and its basement structure and raft foundation. Refer to the project drawings for extents of proposed basement demolition.

(f) Contract drawings / project drawings

The Contractor shall take account of all project-specific drawings and general notes provided by the Principal Contractor in relation to the proposed piled items described in clause B1.2(c). All final design drawings shall be included within the relevant scopes of work to be provided by the Principal Contractor.

The following list of drawings shows key piling layout and loading requirements for the project:

- CASICD-MMD-XX-FN-DR-S-000230
- CASICD-MMD-XX-FN-DR-S-000231

- CASICD-MMD-XX-PL-DR-S-000200
- CASICD-MMD-XX-PL-DR-S-000201
- CASICD-MMD-XX-PL-DR-S-000210
- CASICD-MMD-XX-PL-DR-S-000211

The project drawings listed above show the required number and layout of bearing piles, with unique I.D. references and setting-out coordinates. The following additional piling details are included on the drawings and schedules for the attention of the Contractor:

- Specified Working Load (SWL) / representative actions (with permanent and variable split to support Eurocode 7 (EC7) pile design).
- Preferred pile diameters (subject to Contractor's design) to suit structural pilecaps.
- Pile head Cut-Off-Levels (COL). Trimmed pile heads shall be embedded 75mm into reinforced concrete substructures.
- Working platform level (anticipated) for commencement of pile installation.

The Contractor shall raise with the Principal Contractor any discrepancy identified between this Project Specification and any piling information conveyed on the project drawings, for timely resolution.

(g) Construction tolerances

The minimum requirements as stated in Section B1.8 and Table B1.4 of *SPERWall* are considered to apply for all bearing piles.

The Contractor shall account for the anticipated piling platform level (commencing surface) and the stated pile COL in the design and execution of the piles, with suitable allowance made for projecting steel reinforcement bars above pile COL and planning of the pile installation sequence. The Contractor shall advise the Principal Contractor of the minimum depth of pile head trimming necessary, for quality control purposes, to ensure that no contaminated concrete exists below pile COL in any piles.

(h) Submission of information (in addition to Table B1.1)

The information which shall be submitted by the Contractor at the stated stages of the piling works contract is listed in Table B1.1 of *SPERWall*. In addition, the Contractor shall submit to the Principal Contractor the following information as part of their technical submission:

1. All information listed in Appendix A of this Project Specification.
2. Details of the Contractor's experience in designing and constructing their proposed pile type(s) in ground conditions similar to those at the Christie Hospital site; including information on the number and size of piles previously constructed/installed and their ultimate load capacity and performance characteristics under test loads.
3. With reference to the site-specific ground conditions, the Contractor shall estimate the anticipated time period for the construction/installation of one complete pile and the number of piles per day per rig. An explanation of the construction process/sequence shall be submitted to cover the installation of bearing piles.
4. The type, dimensions and number of piling rigs (including rig power/torque) and ancillary/attendant equipment and plant proposed to be utilised by the Contractor for the piling works.
5. Anticipated minimum hardstanding and storage area (in m^2) required by the Contractor for the erection, storage and maintenance of piling rigs, equipment, and ancillary plant; the storage of materials; and the manufacture and storage of steel reinforcement cages.

6. Details of anticipated noise and vibration levels occurring during piling activities and the Contractor's proposed method of mitigating and monitoring these.
7. Details of how the Contractor proposes to minimise the total amount of pile head trimming to final Cut-Off-Level required to be undertaken on-site, and/or the work associated with this activity, whilst maintaining safety and quality standards for their piling operations.
8. Description of methodology for dealing with potential early pile refusals (subject to piling method) due to ground obstructions.
9. Description of methodology for dealing with the situation where rock type, strength and/or condition encountered during pile construction deviates from that assumed in the design based on the GI data. The methodology shall include how the design rock embedment and design parameters are to be confirmed on site using the Contractor's selected piling method (i.e. BCIP or CFA). With use of CFA piles, provide details (including typical / template record sheets) of automated installation monitoring and verification of reliable penetration into competent bedrock.
10. Description of methodology for demonstrating / verifying that designed rock socket length / rock embedment has been formed on site using specific piling methods proposed.
11. Description of methodology for clearing out the base of rock sockets as applicable to piling method proposed and design requirements.
12. Calculations (in accordance with Eurocode 7 Part 1) for the design of the bearing piles.
13. Construction Programme for the piling Works.
14. Health and Safety Plan including RAMS for all piling activities.

(i) Responsibility for design, including any division of this responsibility

The Contractor is responsible for the design and performance of individual piles in accordance with *SPERWall* Clause B1.4: Design Option 2 – 'Contractor provides design of piles and/or embedded walls'.

The Contractor shall determine the pile type, pile size, pile length (including rock socket / rock embedment design) which suits the piling layouts, ground conditions, and satisfies design and performance criteria contained within this Project Specification and agreed with the Principal Contractor. The Contractor shall refer herein and to the project drawings and schedules for pile loading and performance criteria.

Clarification of design responsibilities is shown below.

Design Responsibility	Foundation Scheme Designer	Contractor (Piling Sub-contractor)
Design of Foundation Scheme: Including layout of piles, configuration of pile groups, specification of pile loads and performance criteria.	✔	
Choice of Pile Type / Method: Subject to the constraints set out in the Project Specification and ground-related risks identified from the site-specific ground investigations.		✔
Design of Bearing Piles: Structural and geotechnical design to achieve specified performance requirements and to carry loads / actions within the tolerable limits of displacement.		✔

The Contractor is required to submit full details of the pile type(s) proposed including dimensions, reinforcement, concrete, and design calculations (structural & geotechnical), along

with design ground profile and predicted pile performance. All pile types proposed by the Contractor must satisfy the constraints for piling and fulfil the specified performance criteria as stated herein including (1) Eurocode 7 Design Limit States, (2) load-deformation performance at working loads, and (3) durability throughout the design life of the structures.

The Contractor shall design the concrete mix for the piles based on the requirements stated herein, taking cognisance of the site-specific ground aggressivity, and to support the proposed method of concrete supply and placement.

(j) Design standards and criteria for the piles or walls including design life

The Contractor is required to design piles which fulfil the following minimum criteria;

- Partial factors of safety in Eurocode 7 Part 1 (BS EN 1997-1) and UK National Annex.
- Performance requirements for load capacity, deformation/settlement, as stated herein.
- Remain durable throughout their design life – required to be a **minimum of 50 years**.

The Contractor is required to design, construct and test piles in accordance with Eurocode 7, current European Execution Standards, *SPERWall*, UK best practice guidance set out by the Federation of Piling Specialists (FPS), and this Project Specification.

(k) Constraints on design including the need to verify design assumptions

Several constraints are present at the site, as summarised in Clause B1.2(c) and (d), which should be considered by the Contractor in relation to the design, construction, and programming of the works.

All piles shall be socketed / embedded into the underlying bedrock as required with the extent of rock penetration to be determined by the Contractor through calculation and verified by static (maintained) load testing on working piles. Rock socket / embedment shall be consistent across all piles with comparable loads, and shall be accurately recorded on site and in the pile records.

(l) Working platform and commencing surface level

Prior to the commencement of piling activities on site a working platform shall be constructed across the various site areas to facilitate the trafficking of heavy plant items including mobile cranes and piling rigs. Working platforms shall be designed, constructed and maintained in accordance with ‘Working Platforms for Tracked Plant’ (2004) BRE Report BR470 and the best practice guidance provided by the FPS. The Principal Contractor shall be responsible for the design, installation and maintenance of the working platform.

The Contractor is to agree all piling platform levels with the Principal Contractor and provide FPS formatted piling rig track pressures for the specific rigs proposed to be used on the project.

(m) A schedule of representative actions (or specified working loads if applicable)

Specified working loads (SWL) in compression, tension and lateral and provided on the project drawings listed in clause B1.2(f). Loads are provided for different pile designations.

The Contractor shall define the Design Verification Load (DVL) for piles subject to static load tests, as being the stated SWL plus any additional allowances considered applicable.

(n) Pile or wall element dimensions

Refer to Clause B1.2(c) for a summary of bearing piles anticipated under this contract.

A nominal **450mm** diameter is required for the Phase 1 piles, and **600mm** diameter for the Phase 2 piles, to suit group layouts and structural pilecap designs.

The Contractor is required to consider the use of the suggested pile diameters but is permitted to propose additional alternative pile diameter which will meet the specified design and performance criteria, subject to review and acceptance by the Principal Contractor and the Foundation Scheme Designer against scheme compatibility. The Contractor is required to furnish details of the type(s) of pile proposed, including detailed structural and geotechnical design calculations.

All piles are to be socketed / embedded into bedrock as required to generate load carrying capacity and provide appropriate safety margin against the occurrence of relevant limit states.

(o) Preliminary piles and trial bores/drives/panels

None anticipated.

Appropriate partial factors for design shall be selected from the EC7-1 National Annex.

The Contractor shall advise the Principal Contractor of the potential benefit of preliminary piles, if deemed applicable for bearing pile design.

(p) Performance criteria for the structure to be supported on the piles or by the wall

Generally, the serviceability limit state requires that total and differential settlement of column foundations and building cores are limited so as to not impair the stability of the building or that of any other adjacent buildings, highways, or utilities, and will not cause damage to building finishes or building services.

The maximum differential settlement between adjacent load bearing structural elements shall be limited to span/500 (between adjacent structural columns, and between building core and adjacent structural columns).

(q) Performance criteria for piles under test or wall elements during service

The maximum allowable pile head movements (displacements) for individual piles are stated herein. These limits on pile head movement include for deflection, elastic shortening / elongation and settlement.

The following **maximum tolerable displacements/deflections** apply to all bearing piles:

- 10mm at DVL under axial compression
- 15mm at DVL + 50% SWL under axial compression
- 5mm at DVL under lateral loading

The requirements of Table B1.2 as referenced in *SPERWall* are included for within Clause B1.2 of this Project Specification.

Tender submissions shall positively confirm that calculated pile displacement estimates for proposed piles will meet the required performance criteria. Detailed pile design submission shall contain a summary of pile displacement calculations to show compliance with the criteria stated herein.

(r) Sampling and testing of materials (other than concrete)

As per *SPERWall* and as agreed with the Principal Contractor.

(s) Permissible damage criteria for existing critical structures or services

The Contractor shall adopt appropriate piling techniques and methods of working so as not to cause any damage or distress to neighbouring structures or buried services (existing or newly constructed) or adversely affect adjacent site activities.

The Contractor shall refer to pre-construction information provided by the Principal Contractor for as-built locations of existing structures and services.

The Contractor shall define and implement a system of vibration monitoring, to be agreed with the Principal Contractor, to monitor the level of potential vibration caused by piling activities.

(t) Additional temporary works plant and duration of loading for which the working platform should be designed

The Principal Contractor shall ensure the integrity of the Working Platform is maintained for the duration of the piling works.

(u) Site datum and site grid

The Contractor shall refer to pre-construction information provided by the Principal Contractor for details.

The Contractor is required to survey and establish the plan position of the installed piles relative to national grid (to within a tolerance of +/- 5.0mm or otherwise stated by the Principal Contractor), and to establish reduced levels in metres relative to Ordnance Datum (m OD) (to within a tolerance of +/- 1.0mm or otherwise stated by the Principal Contractor).

The Contractor is responsible for the accurate setting out and surveying of pile positions, as per the coordinates provided on the project drawings, in advance of pile installation.

(v) Restrictions on permissible working hours

To be agreed with the Employer and Asset Owner. Restrictions may apply in relation to the site being within an active gas terminal. Refer to pre-construction information.

(w) Restrictions on noise and vibration levels

To be agreed with the Principal Contractor and asset owner. Restrictions are expected to apply in relation to the site being adjacent to existing operation healthcare facilities. Refer to pre-construction information.

Proposed piles are to be installed in close proximity to existing structures which will require safeguards for mitigation of ground borne vibrations. Particular requirements for control and monitoring of vibrations shall be discussed and agreed with the Principal Contractor and asset owner. The precise location of the monitoring devices shall be subject to the approval of the Principal Contractor and the Christie NHS Foundation Trust and shall be reviewed periodically as construction works progress.

Additionally, the Contractor shall comply with the requirements of BS 5228:2009+A1:2014 – ‘Code of Practice for noise and vibration control on construction and open sites’, and adhere to any noise and vibration mitigation requirements of the local authority.

(x) Site investigation including geotechnical and geoenvironmental information, and the need for further GI

Project-specific ground investigations (GI) have been undertaken at the site in 2024 by GRM Development Solutions (report reference GRM/P10525/FAC.1 Rev P01 dated May 2024). The GI factual report should be provided to the Contractor as part of the Pre-Construction Information.

The Contractor is fully responsible for review and interpretation of all available site data and factual ground investigation information to enable sub-surface characterisation to facilitate the design, execution and testing of bearing piles.

Historical ground investigation information (2019 GI by CC Geotechnical Ltd, report reference CCG-C-18-10614 Rev 0 dated March 2019) associated with the redevelopment of the adjacent Paterson Building is available for review and should be used by the Contractor as a supplementary source of ground information.

The Contractor shall identify ground-related risks at the site based on the available data (including information on geology, geo-environmental, geo-chemical, groundwater, buried services, and existing foundations), and from previous experience of piling in similar ground conditions, and take cognisance of these in the planning and execution of the piling works (including the choice of pile type, pile design, and proposed piling plant & equipment).

All piles are to be embedded within the underlying bedrock at the site, penetrating a suitable depth to satisfy ULS and SLS design. Piling plant selected by the Contractor must be capable of reliably penetrating bedrock to the pile design toe elevation without premature refusal.

(y) Disposal of excavated material and trimmed excess pile and wall material

Requirements to be agreed with the Principal Contractor prior to the start of the site works.

(z) Other particular technical requirements

1) Pile types shall not be mixed under individual pile caps and foundations.
2) Installed pile lengths within a discrete pilecap are to be similar and shall not deviate significantly (i.e. should be within a maximum range of one pile diameter).
3) Complete piling records must be collated by the Contractor, to include all information stated in *SPERWall* and this Project Specification. Where the pile design is dependent on achieving a specific pile toe embedment into a given target stratum (i.e. competent unweathered rock), then clear records of this achievement shall be collated by the Contractor for each pile installed.
4) Concrete volumes should be accurately recorded for each pile installed. Where concrete is to be pumped through a hollow-stem auger then control is required to ensure a workable concrete mix is used for each pile.

B3 Bored Cast-in-Place Piles

B3.2 Project Specification

A bored or augered pile type is favoured by the Foundation Scheme Designer. The method proposed by the Contractor shall provide for reliability of installation in the site-specific ground conditions, for consistency of pile rock socket / embedment, and for verification of rock socket / embedment depth. The use of bored cast-in-place piles, if selected by the Contractor, shall be in accordance with the requirements of this Project Specification, *SPERWall*, and the best practice guidance given by FPS.

(a) Support fluid

Not anticipated for this contract. The Contractor is required to determine whether the use of support fluid is required to maintain the stability of open bores in the site-specific ground conditions. The use of support fluid (if utilised) shall be in accordance with Section B20 of *SPERWall*. The Contractor should make particular reference to FPS (2006) Bentonite Support Fluid in Civil Engineering, published by the FPS, if Bentonite is adopted.

(b) Base or shaft grouting

Not anticipated for this contract. If applicable to the Contractor's design, then details shall be submitted as part of detailed design documentation for review and acceptance by the Employer.

(c) Pile shaft and base inspection by closed-circuit television (CCTV) and or sampling/probing (see clause B3.5.8)

Not anticipated for this contract. If applicable to the Contractor's design, then details shall be submitted as part of detailed design documentation for review and acceptance by the Employer.

(d) Details of permanent casings

Not anticipated for this contract. If applicable to the Contractor's design, then details shall be submitted as part of detailed design documentation for review and acceptance by the Employer.

(e) Inspection of underreams

Not considered applicable.

(f) Ribbed piles

Not considered applicable.

(g) Details of plunge columns

Not considered applicable.

(h) Other particular technical requirements

1) If selected by the Contractor as the method of piling for the Christie Hospital project, then details shall be provided as to how the pile toe rock socket will be formed and what testing / inspection will be undertaken on site to demonstrate that the Contractor's design rock assumptions are validated.
2) Any automated data from the piling rig shall be used to supplement the installation records for each pile, as applicable to the plant being used.

B4 Piles Constructed Using Continuous Flight Augers or Displacement Augers

B4.2 Project Specification

A bored or augered pile type is favoured by the Foundation Scheme Designer. The method proposed by the Contractor shall provide for reliability of installation in the site-specific ground conditions, for consistency of pile rock socket / embedment, and for verification of rock socket / embedment depth.

(a) Permitted pile types

Continuous flight auger (CFA) pile type is permitted, if deemed suitable by the Contractor for the ground conditions and performance requirements. The use of CFA piles, if selected by the Contractor, shall be in accordance with the requirements of this Project Specification, *SPERWall*, and the best practice guidance given by the FPS.

Sectional Flight Auger (SFA) pile type is not anticipated for the project due to there being no restricted headroom constraints at the site which would warrant the splitting of augers.

Displacement Auger (DA) pile type is not permitted for the project due to the design requirement for pile toe embedment into bedrock and the proximity to operational healthcare infrastructure.

Information on ground conditions, including the potential risk of cobble obstructions and rock strength and extent of weathering, shall be accounted for by the Contractor in the selection of pile type and installation plant.

(b) Whether a single splitting of augers shall be permitted

Only to be considered if site constraints do not permit CFA or BCIP pile type, and subject to review and acceptance by the Principal Contractor.

(c) Whether concrete supply is to be controlled by pressure or volume (see Clause B4.4.5.3)

The Contractor shall propose their method for controlling the placement of concrete (Method 1 or Method 2 as stated in Clause B4.4.6.3 of *SPERWall*) which is deemed most suitable for the construction of uniform, homogeneous concrete piles of sound structural integrity in the particular ground and groundwater conditions at the site.

(d) Detailed requirements for monitoring records

The Contractor shall provide such records as required by *SPERWall* and make them available to the Employer within 24 hours if requested, and full monitoring records within 72 hours of completion of each pile. Any anomalous pile installation results shall be highlighted by the Contractor as soon as this is evident.

(e) Whether compressed air shall not be permitted to assist with boring

Contractor's remit to suit proposed methodology and assessment of ground conditions.

(f) Other particular technical requirements

1) If selected for use on site, CFA piles shall be constructed using suitably robust and powerful equipment with high torque and tooling capable of penetrating the ground to the design depth without premature refusal.
2) The Contractor shall clearly set out in their technical submission the process for site-based verification of rock socket design requirements for each CFA pile installed. Using the automated installation rig monitoring data as part of the verification process, the

Contractor will be required to demonstrate achievement of rock socket design for each pile.

3) A description of how the CFA rig operator and Contractor's site engineer will interpret the real-time information gleaned from the rig telemetry feedback, drilling rate, applied torque etc. with regards to pile depth and base material shall be provided.
4) CFA installation data traces shall be viewed in light of adjacent borehole logs, and interpretation of potentially variable rockhead levels between boreholes, as part of the design verification process.
5) Practical refusal criteria for CFA pile installation, linked to the site-specific ground conditions, shall be defined by the Contractor within their technical submission. Proposals for dealing with any unexpected 'short' piles shall be agreed with the Principal Contractor, and are likely to include abandonment, downrated capacity, installation of additional pile, or other alternative options.

B15 Integrity Testing

B15.3 Project Specification

Integrity testing of piles shall be undertaken by the Contractor in accordance with the requirements of this Project Specification, *SPERWall*, and the best practice guidance given in CIRIA Report R144 (Turner, 1997) and by the FPS.

Integrity testing, data processing, interpretation and reporting of test results shall be carried out by the Contractor on all piles under this contract (working piles and test piles).

(a) The method of test to be carried out

All piles including test piles (100%) shall be subjected to integrity testing using type (b) methods as stated in *SPERWall* (i.e. low strain sonic or TDR method).

(b) The number, type and location of elements to be tested

As part of the quality assurance testing strategy for the piling works as defined in this Project Specification, all bearing piles shall be subjected to post-construction integrity testing, as stated in clause B15.3(a). Testing shall be used to assess their structural integrity and to ensure they are free from significant structural faults which could be detrimental to performance or durability of the pile in service.

(c) The stages in the programme of works when a phase of integrity testing is to be carried out

Testing shall be coordinated and agreed between the Contractor (and their integrity testing specialist) and the Principal Contractor to make available a number of piles for testing during each testing visit. Piles shall be at least seven days old prior to integrity testing.

Type (b) integrity tests shall be carried out on piles at the cut-off level following pile head trimming and prior to their incorporation into substructures. Additionally, piles shall be tested as and when directed, where damage is suspected to have occurred to a pile as a result of construction site activities.

(d) Where cross-hole sonic logging is used: the number, location and length of access ducts to be uniformly placed and the material from which the ducts shall be made. The sampling interval over the required depth shall not be greater than 0.25m

Not applicable.

(e) Where distributed fibre optic sensing is used: the number and location of fibre optic cables to be installed in each element, the depth over which the testing is required, and the sampling interval (but not greater than 250mm)

Not applicable.

(f) Where thermistor based testing (thermal integrity profiling) is used: the number, location and length of embedded thermal sensor cabling to be placed. The thermal sensor cables shall be aligned with the longitudinal reinforcement of the element. Where embedded sensors are employed, the distance between embedded sensors shall not be greater than 0.5m. Where fibre optic cable is used the following shall be specified: minimum spatial resolution (not be greater than 1m), the minimum precision required and that absolute temperature is measured rather than changes relative to a baseline

Not anticipated.

(g) The time after testing at which the test results and findings shall be available to the contract administrator, if different from the requirements of Clause B15.8

The reporting of integrity test results shall be in general accordance with Clause B15.8 of *SPERWall*. Interpretation and reporting of test results shall be carried out by the Contractor and submitted to the Principal Contractor for review and comment.

The results of integrity tests conducted on piles which are designated for static load testing shall be submitted prior to the commencement of any pile head preparations necessary to facilitate load testing.

A report of integrity test results shall contain a paragraph of conclusions that summarises the opinion of the Contractor as to the integrity of the piles tested For example, if no clear signal response is detected from the pile toe using TDR testing, and no significant reflections are observed along the pile shaft, the Contractor should comment as to what depth in their opinion the test results indicate the pile shaft to be free from significant structural faults prior to the loss of stress-wave energy through signal damping. Comment should be made by the Contractor on the likely cause of the signal attenuation and the length of the pile over which its integrity is deemed inconclusive from the test results.

(h) Where acoustic methods clause B15.2 (a), (b) and (c) are used: the number of days to elapse between casting and integrity testing

Integrity tests shall not be carried out on in-situ concrete piles until a minimum of 7 days (or otherwise directed by the Employer) has elapsed since the time of pile casting to allow for sufficient concrete curing.

(i) Where thermal methods clause B15.2 (d) and (e) are used, the maximum time from concrete casting to the start of monitoring, and the interval between consecutive measurements (that shall not be greater than 30 minutes). The minimum duration of monitoring from concrete casting shall also be specified

Not applicable.

(j) Where temperature methods are used: the orientation of the cables shall be noted to aid further intrusive investigation if required; preparation of concrete surface of test element for testing using the methods (a) or (b) in B15.2 of the ICE Specification

Not applicable.

(k) Other particular requirements

None.

B17 Static Load Testing of Piles

B17.2 Project Specification

Static load testing of piles shall be undertaken by the Contractor in accordance with the requirements of this Project Specification, *SPERWall*, and the best practice guidance given by the FPS.

Static load testing, data processing, interpretation and reporting of test results shall be carried out by the Contractor on piles at two locations across the site.

(a) Type of pile

Static load tests shall be undertaken on 1% of the total number of Working piles on the site.

Provisionally, two (2 no.) static load tests (axial compression proof load test) shall be undertaken on representative working bearing piles within the Phase 2 piling site area. The location of the piles to be tested will be subject to the agreement of the Principal Contractor and Foundation Scheme Designer.

In addition to the precise pile head level monitoring of the working piles subjected to proof loads, precise pile head monitoring shall also be undertaken on the corresponding reaction piles to measure their load-deformation response under reaction loads. The captured load-deformation data from reaction piles will be used to supplement the data captured on the working test piles, for demonstration of pile performance in the site-specific ground conditions. The number of reaction piles required for the working pile tests shall be determined by the Contractor to suit the applied loads, ground conditions and site accessibility.

Static load testing shall be undertaken after the results of integrity tests on the selected piles has been reviewed and accepted. Further static load tests may be required dependant on the results of integrity tests and from review of construction records.

It is not envisaged that static load tests will be undertaken on preliminary (non-working) test piles, however the Contractor shall advise on the potential benefits of a preliminary test if deemed beneficial for the project in relation to validation of design and/or efficiency in pile construction.

(b) Type of test

Static Load testing shall be carried out using the Maintained Load (ML) test method, based on multi-cycle proof load test as outlined in *SPERWall.*

The Contractor shall provide details of the pile test set-up and reaction system including apparatus for application of load and measurement of pile head deformations (on working pile and reaction piles).

(c) Loads to be applied and procedure to be adopted in testing preliminary piles, including maximum reaction capacity

No preliminary test piles envisaged.

(d) Loads to be applied and procedure to be adopted in proof-testing of working piles, including maximum reaction capacity

The cyclic loading and unloading regime on the piles shall be carried out as agreed with the Principal Contractor. Tests should be carried out in general accordance with Clause B17 of *SPERWall.*

The Contractor is required to determine the Design Verification Load (DVL) for the pile test, to suit their specific pile design. The calculated DVL should be appropriate for the situation of the pile test and the loads which will be applied to the pile in service.

(e) Whether test is to be compression or tension and number of loading cycles

Tests shall comprise compression load tests on piles.

Static load Tests on Working Piles shall be carried out in 2-load-cycles, to a maximum test (Proof) load equal to 100% DVL + 50% SWL.

(f) Special materials to be used in construction of preliminary test piles where appropriate

Not applicable.

(g) Special construction detail requirements for test piles, including requirements for additional reinforcement, increased concrete strength, sampling or in situ testing

To be proposed by the Contractor, if applicable.

(h) Special requirements for pile testing equipment and arrangement, including requirements for any pile instrumentation

No special non-standard instrumentation required on pile tests.

(i) Pile installation criteria

To be in accordance with *SPERWall*.

(j) Time interval between pile installation and testing

The time interval between casting of an in-situ concrete pile and commencement of static load testing shall be a minimum of 14 days, unless otherwise directed or agreed by the Principal Contractor. A shorter time interval may be accepted to aid overall programme and the duration of the piling works.

(k) Whether interpretation is required and extent of interpretation

A report of static load test results should contain a paragraph of conclusions that summarises the opinion of the Contractor as to the performance of the piles tested.

Test data on preliminary pile performance and reaction pile performance (under reaction loads) shall be summarised and reported including graphical display of captured data as per standard industry practice and in line with *SPERWall*.

(l) Additional records or information required from the load test

None anticipated.

(m) Displacement transducer stem travel

Details to be included in Contractor's pile testing method statement.

(n) Cut-off level for test

The Contractor shall carry out static load tests at a level agreed by the Principal Contractor. Cognisance must be taken of pile length during test and any implications on the representativeness of the test results to working pile length below defined COL.

(o) Details of work to be carried out to the test pile cap or head for the test and at completion

To be in accordance with *SPERWall* and the Contractor's method statement.

(p) Special requirements for the application of a lateral load to a pile detailed in accordance with the expected conditions of loading

Lateral load testing on Working Piles is not anticipated.

(q) Other particular technical requirements

None.

B21 General Requirements for Concrete, Mortar, Structural Grout and Steel Reinforcement

B21.1 Project Specification

1. General requirements for concrete and steel reinforcement shall be in accordance with Section B21 of *SPERWall*.
2. The Contractor is responsible for assessment of the ground conditions (aggressiveness of ground and groundwater) at the Christie Hospital site and for provision of an appropriate design concrete mix for the bearing piles. Reference shall be made to BRE Special Digest-1 (BRE SD-1).
3. Pile reinforcement shall extend as shown indicatively on the project drawings and be connected into the reinforced concrete pilecap / substructures. Pile steel anchorages shall comply with Eurocode requirements and the project drawings.
4. Minimum concrete cover to pile reinforcement is to be 75mm, unless otherwise agreed.
5. Debonding foam/sleeve should be applied to vertical steel reinforcement above pile COL before casting concrete to assist in pile head trimming.
6. The Contractor shall submit with their design and technical submission details of the proposed structural concrete under this contract. The Contractor's proposed strength class of concrete should be appropriate to meet the pile design.
7. The Contractor shall undertake concrete verification testing on every batch of wet concrete delivered to the site, including slump tests.
8. A minimum of 6 no. concrete cube samples shall be taken by the Contractor per shift for subsequent testing of concrete strength.

Appendices

Appendix A Documentation Required

The Contractor shall supply all information required by ICE *SPERWall* and this Project Specification, and also include the following:

Design stage:

1) Details of the piling rig and BR470 compliant piling rig track pressures for the rig(s) to be used on site.
2) Geotechnical Design Report (GDR) in compliance with Eurocode 7 Part 1 for the pile design. To include geotechnical and structural calculations for ultimate and serviceability limit states. Design calculations to justify pile length and diameter, rock socket design dimensions, concrete design, and steel cage design. Report to also include assumptions on interpreted design ground conditions, interpreted rockhead levels and rock strengths, pile design utilisations to EC7, estimations of settlement/deformation under load, and justification for design concrete class. Draft submission for review by Principal Contractor and Foundation Scheme Designer and final submission addressing any comments.
3) Clear methodology for how design rock socket assumptions, which underpin the estimated pile performance, are to be confirmed on site for each pile prior to concreting of each pile.
4) Target rock properties and site observations to enable confirmation of design.

Prior to mobilisation to site:

5) Comprehensive project-specific risk assessment and method statement (RAMS) covering all aspects of the piling work including mobilisation, plant & equipment, pile installation, pile & material testing, demobilisation, and reporting.
6) Proposed sequence of pile installation and working platform extents to suit the proposed rig and method of work.
7) Plan details of proposed access routes to the site and to each pile.
8) Plan details of hardstanding and storage area for the erection, storage and maintenance of piling rigs, equipment, and ancillary plant; the storage of materials; and the manufacture and storage of steel reinforcement cages.
9) Details of anticipated noise and vibration levels occurring during piling activities and proposed method for mitigating and monitoring.
10) Detailed and resourced programme covering all aspects of the piling work including mobilisation, pile installation, working pile testing, integrity testing, demobilisation and reporting. To include details of plant, crew and supervision on site.
11) Draft pile installation record showing all information to be captured for each pile installed.
12) Draft quality assurance records.
13) Details of pile testing methodology and equipment including certifications for sensitive load and measurement apparatus.
14) Details of method for advancing through obstructions, if encountered prior to reaching design pile toe elevation.
15) Quality control plan to cover all aspects of the works.
16) Details of any subcontractors proposed to be used for any aspect of the piling contract.
17) Details of site staff including supervisory staff, with qualifications and experience CVs.
18) Health and safety plan.

During site works execution:

19) Progress updates to detailed and resourced programme covering all aspects of the piling work including mobilisation, pile installation, working pile testing, integrity testing, demobilisation and reporting. To include details of plant, crew and supervision on site.

20) Complete construction records for all piling and testing work including a detailed installation record for each pile. Electronic rig installation data is to be captured and provided for each pile to supplement construction records. This will include details of applied torque, rate of penetration and any other details captured and used by the rig operator for installation quality assurance.
21) Accurate concrete volume used in formation of each pile.
22) Concrete quality test results, including concrete acceptance tests prior to use and concrete strength test data after curing periods.
23) Records of rock socket verification from site data, piling rig instrumentation and observations.
24) Results of non-destructive integrity tests for each pile, in the form of a testing report with clear conclusions on pile quality / integrity. Applicable to all piles, namely test piles, working piles and anchor piles.
25) Results of static load tests on working piles, in the form of a testing report with clear conclusions on pile load-settlement response.

At completion of site works:

26) Full set of as-built piling records compiled into a single submission for record file purposes. To include all documentation referenced in ICE SPERWall, the Project Specification, and as outlined above, as a minimum.

