Buro Happold

025901Camden BSF

GSHP System

Performance Specification
For Contract
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Revision 1

Buro Happold

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Contents

1 Introduction

1.1 Project Description

This document describes the performance requirements and system descriptions for the Ground Source Heat Pump (GSHP) system for the Camden BSF school, South Camden Community School (SCCS).

The GSHP system shall provide both heating and cooling to contribute towards three targets to be met by the schemes:

- Sustainability brief; 60% improvement over Part L 2006
- 27 kg CO_2 per m^2 per annum
- Carbon Calculator; 60% improvement over Part L 2002

1.2 South Camden Community School (SCCS)

The school is located close to Mornington Crescent tube station, approximately 1 mile north of the Euston Road.

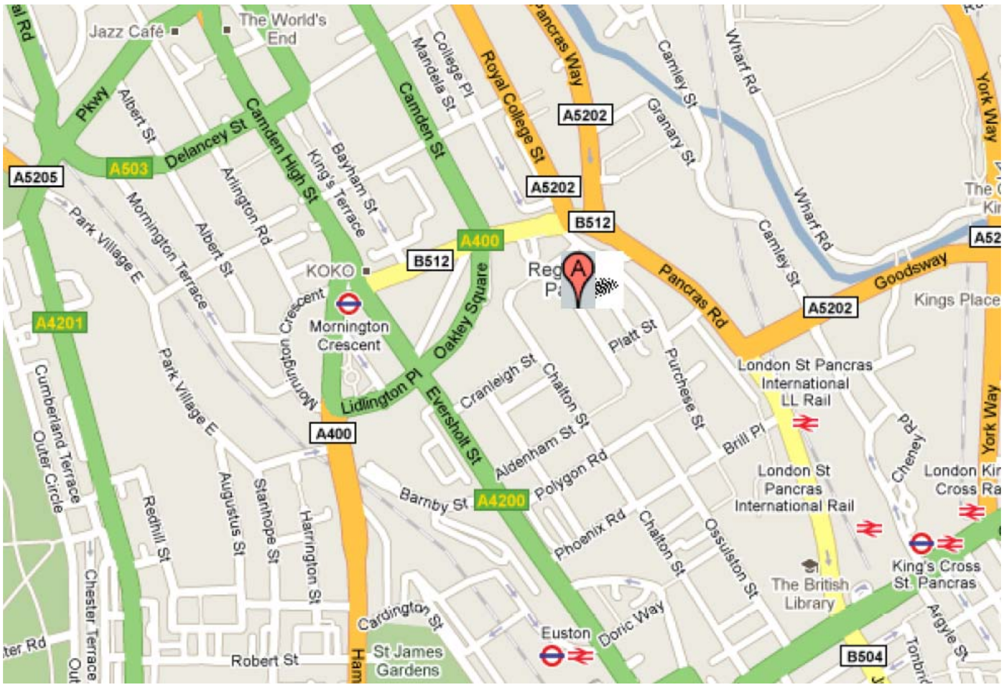

Figure 1: Location of School

The school has a gross floor area of 13441 m², over 3 levels, with elements of new build and refurbished areas. All will be linked to the GSHP system.

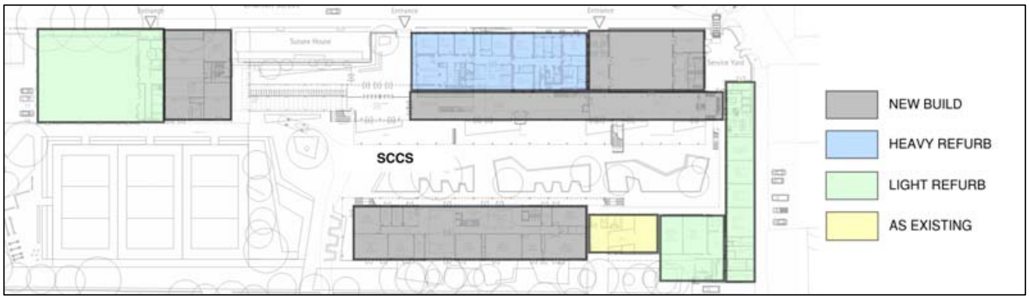

Figure 1: Overview of works in completed form

The area available for a borehole field is indicated on the image below, with a scaled drawing attached for measurement.

The heat pumps will be located on the North corner of the site as shown in the figure below. The boreholes will be located beneath the playground as indicated below. The borehole field size is dictated by the existing buildings on site, particularly the 90s block, adjacent to the borehole field, which will not be demolished until the end of the construction programme.

Note the constraints in SCCS-ME-3800 when considering the borehole array arrangement.

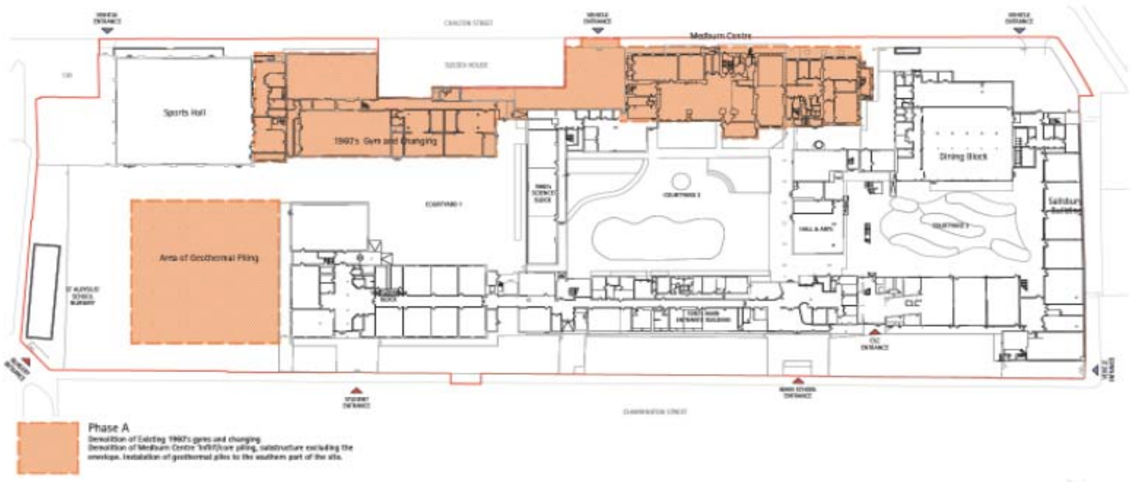

Figure 3: Existing site overview – showing location of borehole field and energy centre location for heat pumps

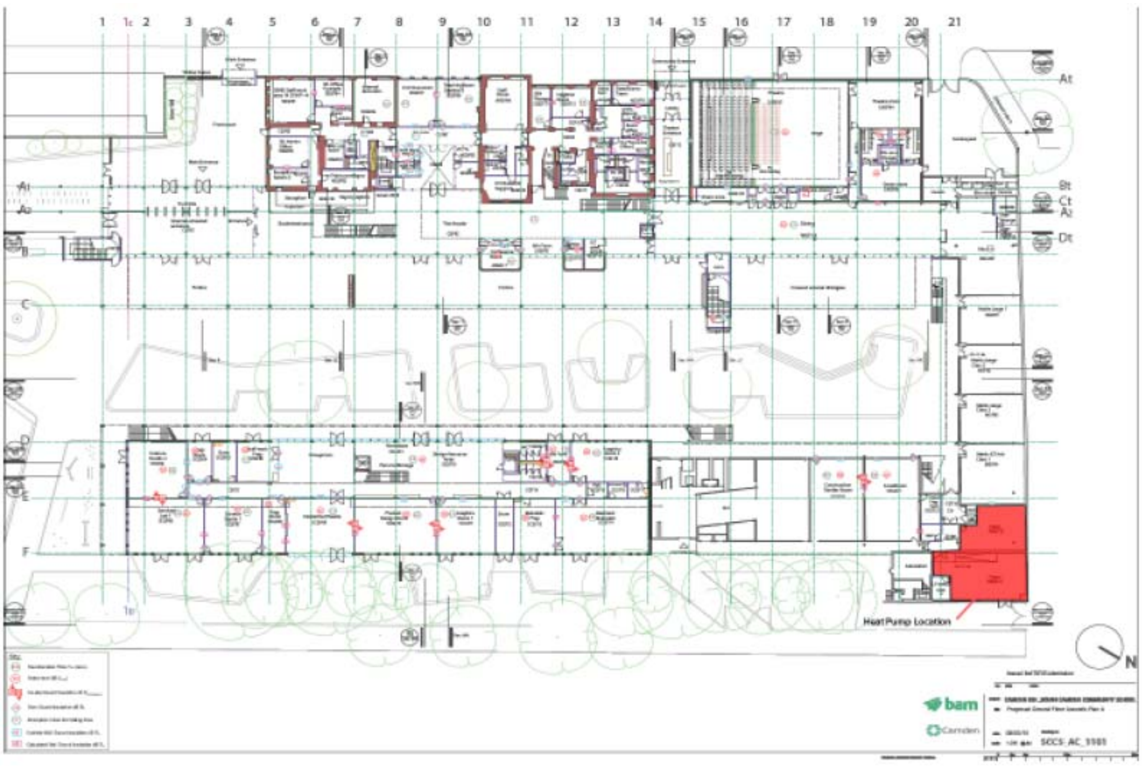

Figure 4: Energy Centre Location

1.3 Phasing

The project will be completed over 5 number of phases. In order to keep the school operational during the construction works a temporary building will be constructed. These buildings shall have shallow foundations, and will not penetrate a depth below 400mm of the sports pitch surface. The heads of the Ground source heat exchangers, and any horizontal distribution shall be deigned to minimise the risk of damage to the boreholes.

The boreholes will be installed in two phases in order to ensure a single sports pitch will remain operational for the duration of the works.

1.4 Standards

Ensure that the design, construction, materials and finishes of all equipment are suitable for the location, climatic and operating conditions to which the installation will be exposed.

Ensure that the whole design & installation complies with the relevant current standards, including the following:

- BS EN 378 – Specification for Refrigerating systems and Heat Pumps and current IEE regulations.

Ensure that the whole installation also complies with the following:

- Current Building Regulations Approved Documents
- Building regulations
- British Standards and Codes of Practice
- Health Technical Memorandums
- Water Bylaws
- BSRIA
- CIBSE
- Manufacturer’s Recommendations and Requirements

2 Scope of Works - Overview

In brief, to design, supply and install fully automatic vertical closed loop ground source heat pump system installation to provide space heating and cooling to the school.

A ground source heat pump design shall be provided to serve heating and cooling loads to the building in accordance with the design parameters and drawings. (See section 8 of this document for a list of current drawings & documents). The ground source heat pump installation shall make use of a vertical closed ground loop circuit.

The water to water heat pumps shall be complete with evaporator and drain pan, compressor, condenser, expansion valve, controls, interconnecting pipework and accessories mounted in a single casing suitable for indoor applications as specified to make a complete fully operational system.

All plant and equipment associated with the GSHP installation shall be located in the main energy centre at the North of the site (Figure 4). All equipment shall be designed with adequate access for maintenance and repair in compliance with all current Health and Safety guides.

The heat pumps shall be capable of modulation through the use of multiple scroll or screw compressors to enable high efficiencies at part load. A turn down ratio of 25% is required for each heat pump.

The GSHP shall report the system expected seasonal COP, based on the loads as supplied and prevailing local conditions. A seasonal performance factor of 4 shall be achieved in heating mode, and 7.5 in cooling load.

The borehole array number of boreholes and spacing shall be optimised to ensure that the reported system seasonal COP is maintained over a 20 year period. A simulation shall be performed by the GSHP contractor to predict the monthly ground temperatures, seasonal performance factor in heating and cooling modes and minimum evaporator entry temperature and maximum condenser leaving temperature.

The GSHP contractor shall be prepared to provide details of calculation methodology and outputs to the design team.

The GSHP installation shall be designed to accommodate simultaneous heating and cooling demand. All items of control equipment shall be compatible with each other and with the BMS.

The GSHP contractor will be responsible for co-ordination and interfacing with BMS designer/contractor.

The BMS contractor shall in conjunction with the GSHP contractor configure controls so that optimum thermal efficiency is achieved at all times, such that load is matched without excessive cycling. Provide buffer tanks for heating and cooling with a minimum size of 20 litres/kW output on both the heating and cooling sides.

The buffer tank shall be sized to minimise heat-pump cycling and enable the cooling demand on the critical loads (server loads etc) be met whilst the solar thermal system recharges the ground.

It is the specialist contractor's responsibility to obtain and verify the characteristics of the ground conditions, and the likely effects on the system performance using desktop analysis and on contract award through the completion of a thermal response test (TRT).

The GSHP contractor will also be responsible for conducting a thermal response test prior to starting the main drilling works to confirm the thermal conductivity and undisturbed ground temperature. The specification for the TRT is detailed in section 4.

The GSHP Contractor shall be responsible for ensuring that the design is spatially consistent with the works of the main contractor. The GSHP Contractor shall also be responsible for the detailed co-ordination with the M&E subcontractor, foundations subcontractor and all other trade Contractors to ensure adequate access provisions to all components for repairs and maintenance.

The GSHP Contractor shall beresponsible for Co coordinating with the main contractor the existing site and routes prior to commencing the production of working installation and builders work drawings.

The GSHP Contractor shall be fully responsible for the design, supply, deliver to site, installation, detailed co-ordination, cleaning, testing, commissioning and setting to work of the entire GSHP heating system to suit the specific requirement of the site. The entire GSHP heating system includes the following:

- Heat Pumps
- Heating circuit buffer tank
- Cooling circuit buffer tank
- Ground Loop Heat Exchanger (GLHE) – Vertical Boreholes
- CHW Heat Exchanger (for connection to CHW distribution system)
- LTHW Heat Exchanger (for connection to LTHW distribution system)
- Solar Thermal Heat Exchanger (for connection to solar thermal system)
- VSD GLHE Circulation Pumps (Duty/ Standby)
- VSD Primary Heating Pumps (Duty/ Standby)
- VSD Primary Cooling Pumps (Duty/ Standby)
- Supply/ return pipe work, connections and manifolds for vertical boreholes, manifolds and heat pumps
- Main services trench to be prepared by others, GSHP pipework to be laid and connected by GSHP contractor from borehole array to the energy centre
- GSHP will make all electrical connections within energy centre including all Isolators to heat pump units
- Controls, including the heat pump modulation controls, integration with the site BMS system, and monitoring.
- Anti vibration and acoustic measures
- Electric power, including connections to the site power
- Heat Metering (including temperatures) for the ground loop and heating and cooling distribution, one per common circuit – one on the evaporator loop and one on the condenser loop.

- Pipework, valves, supports and all ancillaries to complete the system installation
- Cleaning, flushing, chlorination, testing and commissioning

The system shall require a minimum of attendance for system checking and maintenance. This specification does not cover the installation of the heating and cooling distribution, or the structure in which the heat pump(s) and ancillary components shall be installed.

The contractor shall ensure that trenching takes account of existing utilities, tree roots and existing foundations.

This section shall be read in conjunction with all the other tender documentation of the project.

Tender return must use the following standard assumptions for the sizing of GLHE:

- Minimum ground flow loop temperature = 0ºC
- Maximum ground flow loop temperature = 35ºC
- Thermal Con = 1.7W/mK
- Specific Heat Cap = 2160Kj/Km^3
- Pipework = 40mm Dia
- Grout Thermal Conductivity = 1.2W/mK

Ground Conditions

The ground conditions will need confirmation by the GSHP contractor following interpretation of British Geological Borehole logs and other public domain literature as necessary at the tender stage. A thermal response test is required to further assess the geological conditions following award. The necessary requirements for this are provided within this specification and the GSHP contractor should price separately for theses works.

Enabling works

The GSHP Contractor shall be required to provide, within the tender return, an outline description of any anticipated civil and building works not to be included within their proposed scope of works. To include, but not limited to;

- construction of any external manifold chambers
- horizontal trenching in between the borehole array/ external manifold chamber
- plinths within the main plant room

The purpose of which shall be to help evaluate the costs associated with this element of the works. The GSHP contractor is asked to provide sketch details and anticipated civil and builders works.

GSHP Heating and Cooling System

The system (under responsibility of the GSHP contractor) shall consist of the heat pumps, buffer tanks, heat exchangers and associated supply and return pipework, valves, control sensors and panel, fittings and manifold.

The M&E contractor will make connections to flow and return from the respective heating and cooling heat exchangers and solar thermal heat exchangers. All other GSHP system components to be installed and commissioned by the GSHP contractor.

The water (glycol mix) to water heat pumps shall be rated to the required thermal output (heating and cooling) and shall be supplied by CIAT, Water Furnace or Viessmann or similar approved. The refrigerant to be used in the heat pump is R407C or 410A.

All plant room pipework shall be heavy grade steel. Each heat pump flow and return connection shall be fitted with a by pass for pre commission cleaning. The primary circuit shall include a combined dirt and air separator. The dirt and air separator shall be temporarily replaced with an in line basket type strainer, also for use during pre commissioning cleaning.

The heat pump and pressurisation unit shall be mounted on ribbed neoprene anti vibration mounts and on a concrete plinth(s) provided by the Main Contractor.

Ground Source Collector Pipework and Fittings

The heat pump shall be coupled to a pumped, ground source vertical GLHE in HDPE. The GLHE pipework shall be distributed via a manifold and should be installed beneath the school playground. The GSHP contractor shall ensure co-ordination with existing and proposed civils infrastructure.

The main flow and return from/to the manifold to the plant room shall be fitted with a bypass for pre commissioning cleaning and shall include a combined dirt and air separator. The dirt and air separator shall be temporarily replaced with an in line basket type strainer, also for use during pre commissioning cleaning.

Water pressure in the ground loop shall be maintained automatically by a pressurisation unit incorporating a thermal expansion vessel and water make up. Water quality in the heating system shall initially be achieved by manual pre commissioning cleaning and maintained by chemical addition, when required, at a dosing set fitted across the primary circuit.

The borehole construction should be completed in accordance with the “pipework installation” methodology noted in 4.3 for the thermal response test.

It is important that the borehole construction seals off the uppermost Made Ground, sands, silts and London Clay with the chalk so that there is no continuity. This is to ensure that no cross-contamination can take place. Further details can found in Section 7.3 (p. 116-117) of Technical Aspects of Site Investigation Volume II - R&D Report p5-065/TR (Environment Agency 2000).

3 System Description and Performance Objectives

3.1 Overall Heating & Cooling strategy

The heat pumps serve as the primary source of heating & cooling to the South Camden School and serve as part of the active and renewable energy strategy. There will be full gas back-up for heating and hot-water services. Solar thermal collectors will serve the hot water system and also be connected to the GSHP system to allow any excess heat to recharge the boreholes.

The GSHP system will be designed to provide all the cooling, including IT server rooms and cold store heat rejection. Cooling to general spaces will be via cooled fresh air supply in summer. Background cooling via underfloor circuits may be utilised if required or seen as beneficial to the scheme. Air cooled condensers may be required as a back-up to system critical areas e.g. server rooms.

3.2 Sequencing of Works

Proposed Sequence of Works (this may change following award and confirmation of preferred programming)

1. Completion of a thermal test (TRT) within the first borehole completed.
2. Installation of boreholes, including drilling, grouting and u-tube. Borehole by borehole pressure testing.
3. Installation of connecting horizontal pipework between each borehole. Intermediate testing for grouped boreholes on each return header. Installation of return/flow pipework from each borehole group header to predefined area for external manifold chamber.
4. Installation of ground loop circulation pump (duty/standby VSD), main manifold, valves and pressure testing.
5. Installation of heat pumps, pumps buffer tank, sensors, valves, heat exchangers, control panel within the energy centre, once complete. Installation of connecting pipework from external manifold chamber to energy centre and connection to ground energy system.

Initial (incl. connection to building management systems [BMS]) and seasonal (winter, spring and peak summer conditions) commissioning of the complete system.

3.3 Building Loads and Indicative Sizing

The following energy loads have been developed from dynamic thermal modelling for the project and shall be used in sizing the GSHP array. The loads are direct to the GSHP and are based on provision of 90% of all heating energy and 100% cooling energy demand.

Hourly loads are provided for heating and cooling in MSExcel format. Monthly heat rejection from solar thermal panels are also provided within this file.

The monthly heating and cooling loads are summarised in the following table:

Month	heating (kWh)	cooling (kWh)	Peak monthly heating (kW)	Peak monthly cooling (kW)
January	91416	7440	440	10
February	70903	6720	440	10
March	52879	7440	440	10
April	25380	7200	440	10
May	6929	7946	222	66
June	510	9538	18	170
July	276	10271	14	105
August	0	7645	0	12
September	3086	7375	79	27
October	17443	7440	283	10
November	64902	7200	440	10
December	82562	7440	440	10

The following sizing should form the basis of design and costing:

- Heat pump total capacity – Heating 482.4kW
- Heat pump total capacity – Cooling 420.4kW
- Number of heat pumps – 4
- Heat pump model or equivalent – CIAT DynaCiat 350V
- LTHW Heating buffer vessel size – 9 m^3
- CHW buffer vessel – 5 m^3

3.4 Design development requirements

The Ground Source Heat Pump package is tendered as a Contractor Design Portion, and therefore it is expected that the contractor allow for design development from this performance specification, and co-ordination with other members of the design team. Figure 5 shows the design and control responsibilities expected for the SCCS. The schematic (M700), defines the elements of the system that the specialist contractor will have responsibility to supply, install and commission.

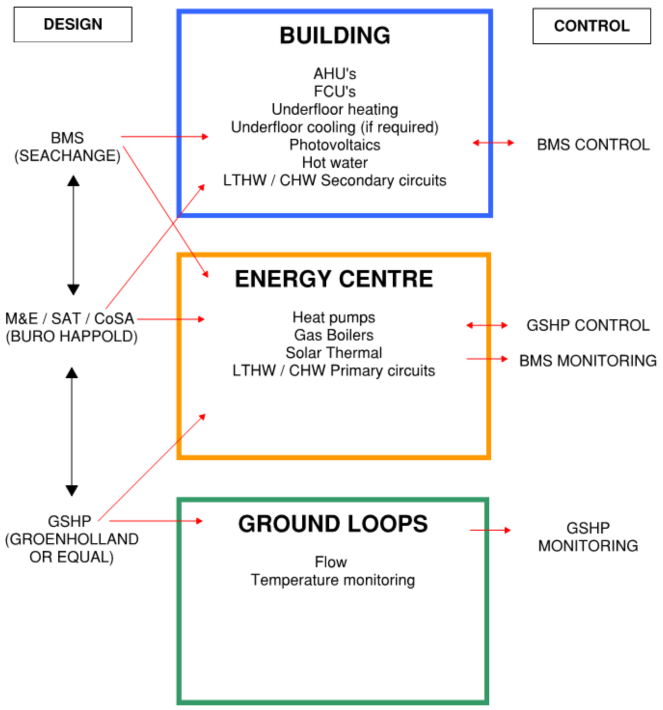

Figure 5: Design and Control Responsibility - SCCS

The following outlines the information/duties to be provided during the design development stage:

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- Up to date heating & cooling profiles for each building (building model)
- Energy proportion required from GSHP system to meet targets
- Main system control strategy & schematic

<u>GSHP Contractor</u>

- Dynamic ground model results including solar thermal recharge
- Borehole plots and general pipe work arrangement
- Confirmation of mechanical schematic
- Confirmation of electrical schematic
- Plant & equipment proposal including controls for main plant

- Energy use of proposed system

BMS Contractor

- Approval of overall control strategy & responsibilities

3.5 Ground Source Heat Pump

The main performance objectives are:

- Peak capacity heating (minimum combined turndown ratio of 10%) – kW based on W7/W45
- Peak capacity cooling (minimum combined turndown ratio of 10%) – kW based on W10/W30
- Flow temperature from ground loop heat exchanger - >-2°C
- Flow/ Return Temperature to heating system - 45 C/ 38C
- Seasonal Performance Factor in heating mode – >4.0*
- Flow/ Return Temperature to cooling system - 10 C/ 14 C
- Seasonal Performance Factor in cooling mode – >7.5*

*COP to include electricity power for heat pumps and GLHE circulation pumps.

3.6 DESIGN PARAMETERS

Refer to the Summary of the design parameters are listed below:

Heating Mode

Heating Peak Capacity	440kW
Secondary Flow Temperature	40ºC
Secondary Return Temperature	30ºC

Cooling Mode

Cooling Peak Capacity	170kW
Secondary Cooling Flow	14ºC
Secondary Cooling Return	18ºC

Pressure drop across each HP	50 kPa*
Plant room temperature	15ºC min
Plant room noise	NR 55 (To be confirmed by GSHP Contractor)
External noise design criteria	50 dBA@ 1 m away from the building (To be confirmed by the Project Acoustic Consultant)
Power available	Three phase, 50Hz

Ventilation Ventilation through mechanical extract (TBC)**

* denotes for information only and to be confirmed by the GSHP manufacturer to achieve best efficiency whilst still operating as LTHW heating system.

** denotes GSHP contractor to confirm supply air volume & free area requirement.

The Heat Pump plant shall be CE Marked.

Power Consumption

The peak electrical power draw of the heat pump(s) must be quoted by the GSHP manufacturer. Where possible all electric circuits shall draw zero power in a quiescent state.

Water Supply

The GSHP contractor shall state any limitations of the heat pump(s) in terms of water pressure, pH, colour, hardness and alkalinity. The contractor should state any other water supply factors that are important to the efficient and smooth running of the heat pump(s) and heat exchanger specified. The GSHP contractor shall supply any water treatment equipment required to meet water quality requirements.

3.7 Basic Control Requirements

The heat pump shall be provided with manufacturer's control panel, sensors (see signal feedback section for more details) and BMS interface unit for installation by the Mechanical Services Contractor. The GSHP contractor will be expected to directly liaise with the controls contractor to ensure the commissioning.

The GSHP Microprocessor controller shall control heat pump start up and maintain constant water flow temperatures for both heating and cooling.

The ground loop heat exchanger pump shall be a variable speed duty/standby installation operated by a pressure differential sensor to ensure the minimum and optimum flow rate is maintained through each heat pump.

The BMS shall be compatible with the heat pump control unit for control and monitoring and the pressurisation unit for alarm monitoring.

A more detailed description of the GSHP is provided in chapter 5.

Interlocks

The necessary interlocks and safety features to permit manual over-rides shall be fitted to each heat pump.

All plant shall stop upon detection of fire alarm within the building. The operation of the plant shall not be affected by the routine fire alarm testing.

Signal Feed Back

To the main BMS package for monitoring, control with data logged recorded to include as a minimum, GSHP Contractor must co-ordinate and ensure equipment signal information is provided to the BMS contractor:

- Heating/ Cooling thermal sub-metering for heating and cooling systems (instantaneous and cumulative monthly totals with reset at start of each calendar month) – (kW/ kWh)
- Heat pump electricity sub-metering (instantaneous and cumulative monthly totals with reset at start of each calendar month)– (kW/ kWh)
- Water temperatures; flow and return to heat pump from GLHE, flow and return to heating and cooling circuits – (°C)
- Individual fault alarm signal for all plant
- Pressure on either side of all pumps
- System and plant operational status
- All motorised valves operation status

4 Thermal Response Testing

The test will include the installation of a 100m deep borehole, inclusive of a single HDPE U-tube grouted throughout the entire depth.

In summary the objectives of the TRT testing are to:

- Confirm the undisturbed ground temperature.
- Measure the bulk average thermal conductivity
- Confirm the geological strata
- Assess the most cost effective drilling depth

The results of the TRT will be used to simulate heat abstraction and rejection to the ground. The GSHP contractor is responsible for obtaining all permits for drilling including alignment to any local regulations. The GSHP contractor must report the results of the test to the consultant prior to the completion of the rest of the drilling works. This will enable confirmation of the number of boreholes needed for the final installation.

The correct installation of a borehole is an absolute necessity to ensure that both short term assessment is accurate but also for sustainable long term operation.

4.1 Pipe work specification

Must be corrosion proof and any exposed pipe work, UV resistant. Main borehole pipe work - High Density Polyethylene (HDPE) prefabricated by electro fused weld and factory tested to a minimum of 6bar (manufacturer - Haka Gerodur or similar).

4.2 Drilling and Soil/ Bedrock Logging

Prior to drilling, a trial pit shall be dug to a depth of 1.5m. Hole must be drilled with a maximum diameter of 150mm to a depth of 150m (+/-5%) below the base of the trial pit. The completed depth will be determined by the realised depth of the u-tube. Drilling method should be mud rotary or compressed air depending on the geological conditions. Soil/ rock must be logged at 10m intervals. Prior to installation of the borehole the resting water table level must be measured following a minimum rest period of 24 hours.

Temporary/ sacrificial casing maybe needed in unstable or unconsolidated strata prior to grouting.

4.3 Pipework installation

Pipe work should be filled with water before insertion into the borehole. Insertion can also be aided using a sacrificial weight. Filling of the pipe work is required regardless of the height of the water table. A suitable instrument must then be used to push down the pipe work via a key hole at the base of the u-bend. A grouting pipe should be fed into the borehole in conjunction with the heat exchanger pipe work. A minimum of 5m of heat exchanger pipe should protrude from the top of the borehole.

Once the heat exchanger and grout pipe have been inserted into the ground a further pressure test must be completed. This should be to 6bar for a minimum of 30minutes without a pressure loss of more than 0.2bar.

Following the test the pipe work must be capped off and taped prior to grouting.

4.4 Grouting

The functional purpose of the grouting is to ensure thermal contact with the ground throughout the length of the borehole. This is to minimise the borehole resistance. The recommended bentonite:cement:quartz sand:water ratio should achieve a grout thermal conductivity of not less than 1.2W/mK.

The grouting must be completed from the bottom upwards to ensure a water tight and physically stable borehole construction. Air voids must be avoided in all circumstances; the grouting pipe outlet must remain below the rising filled level.

The loop shall then be filled with a glycol/ water mixture capable of protection to -10°C. The glycol used should be either polypropylene or ethylene or similar. The fluid should be mixed prior to replacement of the water in the borehole.

4.5 Ground Temperature Measurement

Once grouting has been completed the borehole should be left to rest for a minimum of 5 days to allow the bentonite to cure fully prior to testing. If any settling occurs during the initial 24 hours following installation additional grout should be added to the borehole.

Before testing, the initial average ground temperature should be measured either by

- by lowering a temperature probe down the fluid filled u tube, measuring the temperature at regular depth intervals (evenly spaced over borehole depth) and averaging these; or
- by circulating the carrier fluid without heat input for 10-20 minutes, and averaging the temperature readings as the first volume of carrier fluid (corresponding to the volume of the ground loop) emerges from the up flow shank

All above ground piping should be fully insulated with a minimum of 13mm closed-cell insulation or equivalent. Test rigs should be enclosed in a sealed cabinet that is insulated with a minimum of 25mm fibreglass insulation or equivalent. The ambient air temperature shall be recorded during the test, so that possible interference from heat leakage at the surface can be identified.

The Thermal Response Test shall be performed for a minimum of 48 hours. In practice the test should be long enough to yield an interpretable straight line response that is representative of the thermal properties of the borehole.

The fluid temperature injected should be demonstrative of the operating temperature range which is likely to be between 0-20°C. The fluid temperature should be measurable to an accuracy of <0.3° C; the power input (heater plus circulation pump) to <2% and the fluid flow rate to <5% accuracy.

The heat input rate should be the equivalent of 60 W per metre of bore, which is near the expected peak loads on each borehole for the final system.

During testing the standard deviation of input power should be less than 1.5% of the average value and peaks less than +/- 10% of average, or resulting temperature variation should be less than +/- 0.9 K from a straight trend line of a log(time) vs. average loop temperature.

The accuracy of the temperature measurement and recording devices should be +/- 0.9 K. The combined accuracy of the power transducer and recording device should be +/- 2% of the reading. Flow rates should be sufficient to provide a differential loop temperature of 4-5 K. This is the anticipated temperature differential for the actual heat pump system.

Data collection should be at least every 5 minutes.

If retesting of the bore is necessary, the loop temperature should be allowed to return to within 0.9 K of the pre-test initial ground temperature. This typically corresponds to a 10 to 12 day delay in mid to high conductivity formations and a 14 day delay in low conductivity formations if a complete 48 hour test has been conducted. Waiting periods can be proportionally reduced if test terminations occurred after shorter periods.

Once all testing is complete the top of the borehole shall be protected by a small brick chamber with cover and pipe-work should be sealed and the surrounding ground around the test-bore cleared, levelled. The location of the borehole shall be signposted clearly at ground level.

The following results are required in the interpretive report

4.6 Drilling and Logging:

- Confirmation of methodology used including timeline of operations
- Logging results of geology including:
- Full Drill Log
- Respective formation depth (m)
- Depth of any significant cracks/ fissures or caverns
- Type of drilling equipment used
- Water Table rest level in borehole
- Grout manufacturer and ratio

4.7 Results:

Testing log (note: if there are any power interruptions of more than 15minutes the test should be restarted according to the following schedule)

Full equipment specification must be given.

Headline results required:

- Undisturbed ground temperature (˚C)
- Bulk average thermal conductivity (W/mK)

Additional Data Sets required:

- Exact input heat rate (W)
- Temperature flow(in) and return(out) to heat exchanger (˚C)
- Ambient air temperature, external (˚C)

All results should be made available in Excel format.

Once the results have been verified by the consultant, the drilling works for the remainder of the borehole field may commence.

5 BMS Control Strategies

The Heat Pump contractor will work closely with the BMS contractor to achieve the control strategies outlined below. The control wiring and the motorised actuators for valves will be provided by the BMS contractor. The valve assemblies will be provided by the GSHP contractor. The heat pump control system shall be designed to optimise performance during the following modes of operation:

5.1 Ground Loops – Heating dominated

The heat pumps shall be tuned to provide maximum heating output on the heating circuit. The cooling circuit will effectively provide free cooling via the cooling heat exchanger, i.e. for server rooms, cold stores.

The primary circulation pumps shall be tuned to heat pump operation/demand to reduce heat abstraction from the ground.

Modelling interpretation:

Condenser load - compressor power = evaporator abstraction

GLHE abstraction = evaporator abstraction – (heat rejection from server + cold store load)

5.2 Ground Loops – Cooling dominated

Heat pumps shall be tuned to provide the peak cooling load. Free heating to heating heat exchanger available as required, otherwise is heat rejected to ground loops

Modelling interpretation:

Evaporator load + compressor power = condenser rejection

GLHE rejection= condenser rejection - heat load

5.3 Ground Loops – Solar thermal recharge

Recharge circuit to ground loops is driven by the need to reject heat from solar thermal during significant unoccupied periods, e.g. the summer holiday periods and also to improve balance between heat abstraction and rejection from the ground.

Option1

Only occurs when there is no heating or cooling demand (due to concerns about excessive temperature to heat pumps) and when DHW tanks are fully charged.

Solar thermal recharge is predominantly possible during summer.

GSHP must prioritise server and cold store cooling therefore cold side buffer tank must be sized accordingly to allow for recharge period.

Option 2

Solar thermal heat exchanger is continually "in series" allowing dumping at all times

Flow rate through ground loop heat exchanger must be controlled, in addition to minimum flow rate through heat pumps, to optimise temperature to heat pumps and maximise heat rejection to the ground. High temperature pulsing is inefficient

Modelling interpretation:

Add unused solar thermal load as cooling load to monthly totals

5.4 Main Plant – Heating

Primary

Ground Source Heat Pump (GSHP) – heat pumps as ‘lead’ in heating mode to serve buffer vessel and low loss header. Variable speed primary pumps with staged compressor control. All control by GSHP control system with BMS monitoring.

Secondary / Back-up

Gas boilers – Modulating condensing boilers as ‘secondary’ to serve low loss header by temperature mixing circuit. Boilers will be called when return temperature drops below pre-defined limit.

5.5 Main Plant – Hot Water

Primary

Solar Thermal / Gas boilers – Solar arrays pre-heat incoming cold water in via coil in thermal store. Thermal store has secondary coil to connect to heat rejection circuit (controlled by GSHP system).

DHW cylinder is fed pre-heated water and coil fed by LTHW from gas boilers maintains 60ºC water temperature (BMS control)

5.6 Main Plant – Cooling

Primary

GSHP Active mode – Heat pumps operate to provide CHW on the secondary side at (14/18º). Feeds buffer vessel and low loss header. All control by GSHP system with BMS monitoring.

GSHP Passive mode – Ground loops provide CHW on the secondary side at (14/18º) via heat exchanger with no heat pump operation. Feeds buffer vessel and low loss header. All control by GSHP system with BMS monitoring.

Secondary

GSHP Solar Thermal recharge – CHW Buffer vessel to serve IT loads while solar thermal heat store rejects heat to ground to re-charge boreholes.

5.7 Building – Heating

Primary means of heating

Underfloor heating – LTHW (40º/30ºC) fed from main plant header. Variable volume two port system. BMS controls secondary pumps and any DPV's. Manifold actuator control (by UFH supplier) link to room / zone temperature sensors and window position sensors on BMS.

Other – Refurbishment areas may be provided with secondary LTHW circuit (80/60ºC) if required to serve existing or new radiators (SCCS only). To be confirmed subsequent to detailed survey.

Secondary means of heating

Air Heating – Fresh air supply is tempered by LTHW (40/30) to between 18-21ºC. Variable volume, two port system in conjunction with variable speed AHU control. LTHW & AHU under BMS control

5.8 Building – Cooling

Primary means of cooling

Air cooling via AHUs – CHW (14º/18ºC) to cool mechanical fresh air supply by 10º delta T to a minimum of 20ºC. AHU cooling coil control dependent on external weather temperature from BMS. Variable volume, two-port system in conjunction with variable speed AHU control. CHW & AHU under BMS control.

IT cooling - CHW (14º/18ºC) to serve fan coil units in server & hub rooms. Alternative arrangement could be refrigerant DX system with water cooled condensers served by CHW system. CHW & FCU under BMS control.

Secondary means of cooling (peak lopping)

Underfloor cooling – CHW (14º/18ºC) can feed underfloor circuits for background cooling if required, may reduce borehole density and provide future proofing. Flow control at secondary pumps linked to external temperature & humidity sensor. Variable volume, two port system. BMS controls secondary pumps and any DPV's.

Other – Kitchen cold stores to be refrigerant DX system with water cooled condensers served by CHW system. DX unit & CHW under BMS control.

5.9 Further modelling

Note that the design is currently at RIBA stage D. Further modelling is underway to refine the design and ensure that architectural and value engineering changes do not risk the energy targets set for this project.

6 Commissioning Protocol and Handover Documentation

Final handover shall not occur until such time as full load performance has been verified by the Client or Client's representative.

It is expected that the GSHP work will occur in phased packages. The contractor shall enure that pre-commissioning and testing takes place at each stage. As part of the tender return, a method statement shall be provided as to how testing and protection of equipment (caretaker management) shall be managed. As a minimum pressure testing and flow rate verification shall take place. Record drawings shall be provded at the end of each phase as a means of safeguarding pipework and services. Warning tape shall be located above all buried pipework.

Flow rates through each heat pump (evaporator and condenser) should be calibrated in line with manufacturer's guidelines, minimum and optimum rate should be observed.

The COP should be measured and compared to heat pump manufacturer's data sheets; heating and cooling modes for specified flow temperatures.

This will be measured and checked following initial 3/6/9 and 12 month period to ensure GLHE flow and return temperatures remain within limits, and COP is still in accordance with manufacturer's guidelines.

6.1 Guarantees

Manufacturer's guarantees shall be provided for all equipment and warranties transferred as required to the Client.

Note: Testing and commissioning of the installed heat pump and buffer tank shall be provided in line with the CIBSE Commissioning Guide B for boilers and C for Controls.

6.2 Operator Training

Operator training for 2 individuals and routine troubleshooting and maintenance instruction for 2 individuals (including 1 from local heating contractor) must be included as a minimum. Contractor shall provide details of training provision.

6.3 Operation and Maintenance Manuals

Supplier shall provide at least 4x copies of all manuals to ensure the safe and reliable operation of the GSHP and all ancillary equipment.

6.4 As Installed Drawings

Supplier shall provide at least 4x copies of all manuals to ensure the safe and reliable operation of the GSHP and all ancillary equipment. Record drawings of pipework shall be provided not more than 2 weeks after completion of the phase of works. Contractor shall provide a list of reference projects and units of similar equipment with year of installation, duty and names and addresses of customer contacts (3 references recommended).

7 General Requirements

7.1 On Site Training

The contractor shall allow for an on site training session of the entire installation. This shall include all aspects of maintenance and the system.

7.2 Maintenance and Support

The contractor shall include for 12 months defects liability and 'soft landing' monitoring & commissioning period following issue of the practical completion certificate.

7.3 Builders work

The contractor shall provide all builders work information necessary as required by the Main Contractor.

7.4 Programme

The contractor shall confirm a programme of works, inclusive of lead in period, site installation details and commissioning periods.

7.5 As Fitted Drawings and Operation and Maintenance Manuals

The contractor shall allow for production of detailed as fitted drawings, and operation and maintenance manuals.

7.6 CDM Requirements

Any significant residual risks/hazards identified with mitigation/reduction measures shall be described in the design hazard checklist.

8 Schedules

8.1 Schedule of Drawings and Documents

The following is a list of drawings and documents associated with this performance specification. This specification shall be read in conjunction with the drawing revision current at the date of specification issue.

100625 JD Camden BSF Summary of GLHE and GSHP loads and assumptions for issue.xls
M700 - GSHP Schematic – Indicative for costing (plus M3700a,b and c – modes of operation)
BAM Phasing and Programme Information
025901 Camden BSF South Camden Community School Energy Efiiciency and Sustainability Statements (May 2010)
SCCS_AC_1101_Heat Pump Location Drawing
Survey Drawing 0208-RWC-005 01_09_08

9 Tender Returns

The following information is required within the tender return package:

Calculations showing ground temperatures and seasonal COPs over a 20 year period, plus a list of assumptions
Reference Projects of similar scale and application (3 in total)
References and contact details
Experience of and approach to working in the London Clay and Chalk
Method statement for planning, simulation and detailed design
Provide details of simulation software
Complete list of any proposed subcontractors and/or consultants
Method statement for installation, testing and commissioning
Tender assumptions
Indicative borehole layout in plan stating the number and length of boreholes
Updated GSHP schematic, with changes from BH schematic highlighted
Statement on phasing of works, including interfaces with temporary buildings and trenching works
List of any exclusions or variation from this specification

Appendix A – Tender Price Breakdown

The Contractor shall provide a tender price breakdown as part of the tender return:

Tender price breakdown for Ground Energy System

Preliminaries (site setup, temporaries, expenses, travel etc)	______
Project Management	______
Site Supervision	______
Simulation report of complete energy system	______
1: Thermal Response Test	______
2: Borehole installation- drilling, u-tube pipework installation, grouting (minimum grout thermal conductivity of 1.2W/mK, pressure testing for each borehole (with 5% redundancy). Borehole resistance must be lower than 0.12mk/W. Set of working drawings for the completion of the system to be approved by project engineer.	______
3: Borehole connection pipework	______
3: Manifolds, GLHE circulation pumps, valves and headers (within external manifold chamber)	______
5: heat pumps, buffer tanks, control panel, valves, heat exchangers etc to complete the system within the energy centre and connecting pipework between external manifold chamber and energy centre	______
7: Initial and Seasonal Commissioning (including flushing and testing to required capacity)	______
As built record drawings for complete system (including borehole locations, all pipework/manifolds and mechanical/electrical systems	______
Operation & Maintenance Manual (including test certificates)	______
Collateral Warranty	______
Total	______

Other Items:

Basis of tender – number, size and total length of boreholes/pipework and pipework configuration.

Exclusions/Clarifications.

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