Installation and Testing of a 200m Deep Closed Loop Borehole, Stansted Airport

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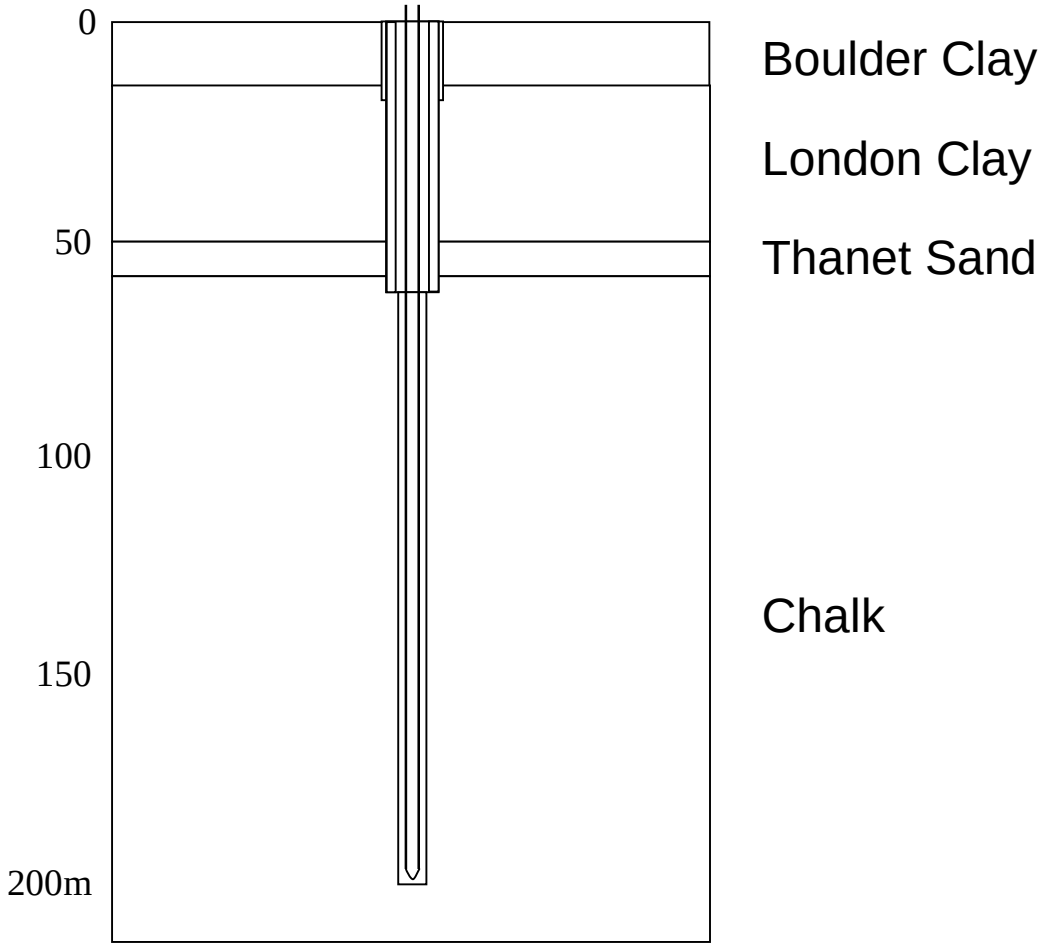
WJ GROUNDWATER LIMITED

Background

- Existing planning consent limits the number of passengers travelling through Stansted Airport to 25M per year
- Stansted SG1 has applied for consent for 35M passengers a year using the existing runway
- Stansted SG2 planning application includes a 2nd runway and terminal, and upgrades to the transport links
- In order to show that ground source heating/cooling is feasible for the site a 200m deep closed loop borehole was installed and tested
- SG2 planning application includes the installation of up to 1500 closed loop boreholes under the proposed car park areas

Ground Conditions

- Temporary casing to London Clay
- Open hole to Chalk
- Hole stability possible issue
- Permanent casing through overlying strata to Chalk
- Open hole to depth
- 40mm HDPE loop installed



Well installation

- Drilled using a 35 ton rotary rig
- 300mm bore to the Chalk
- 178/160mm steel casing installed
- Open hole through Chalk at 150mm bore

Loop installation

- 40/33 mm HDPE loop installed to 200m depth
- Tremie pipe installed to base of well
- Thermally enhanced grout pumped in from the bottom up
- 7.7:1 silica sand : bentonite grout mix, giving a thermal conductivity of 2.02 W/m K
- Grout allowed to set and cool for 5 days prior to testing

Test Parameters

- Power level depends on depth of hole, $P = q \times H$
  - Heat injection, q should be between 30 and 50 W/m
  - For 200m deep hole a power input of 9kW was chosen
- Flowrate around the loop, Q
  - $P = c_v \times Q \times DT_{IN\text{-}OUT}$
  - *where:* c_v is the volumetric specific heat capacity of water 4.2 kJ/kg K

    $DT_{IN\text{-}OUT}$ is the temperature difference between the input and output fluid, ideally 3-5 K
  - Flow of 26 litres/min was used

Thermal Response Testing Unit

- Electric heaters, 1 No. 6 kW heater and 2 No. 3 kW heaters in series
- Recirculation pump
- Flowmeter to monitor recirculated flow
- Sensors to monitor fluid temperature entering and leaving the borehole
- Power meter to monitor the energy input to the heaters
- Datalogger to monitor all sensors, complete with GSM modem for remote access

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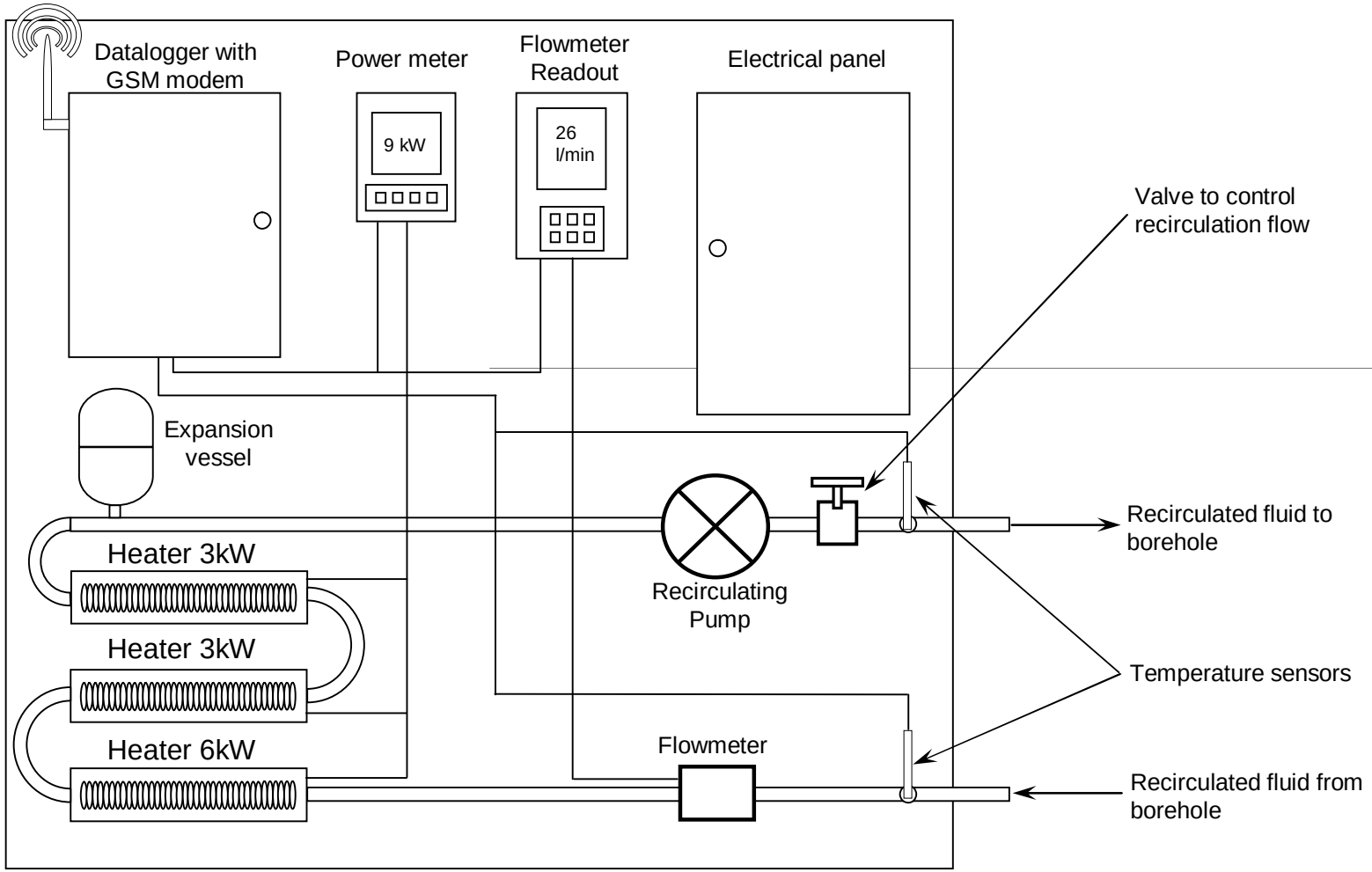
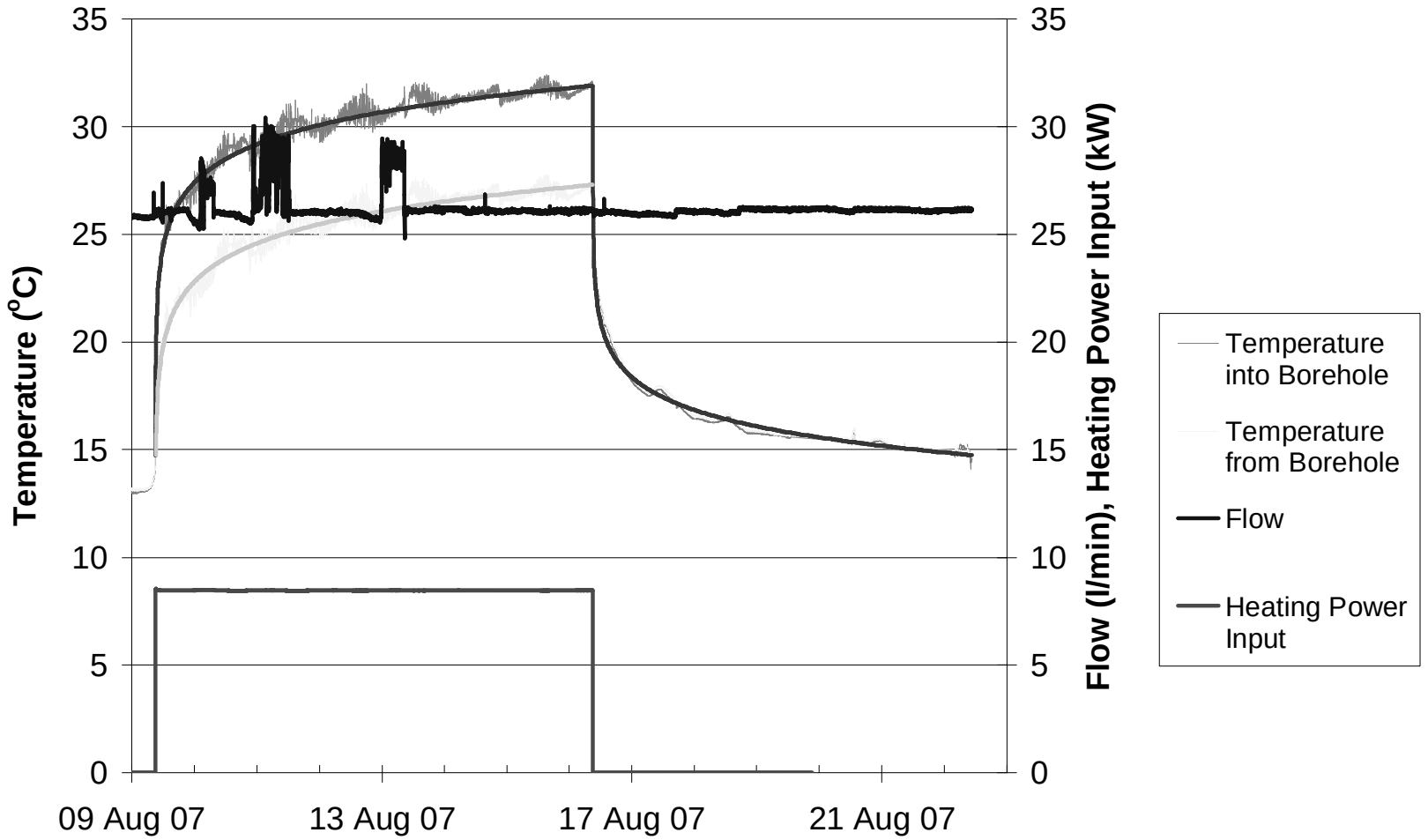
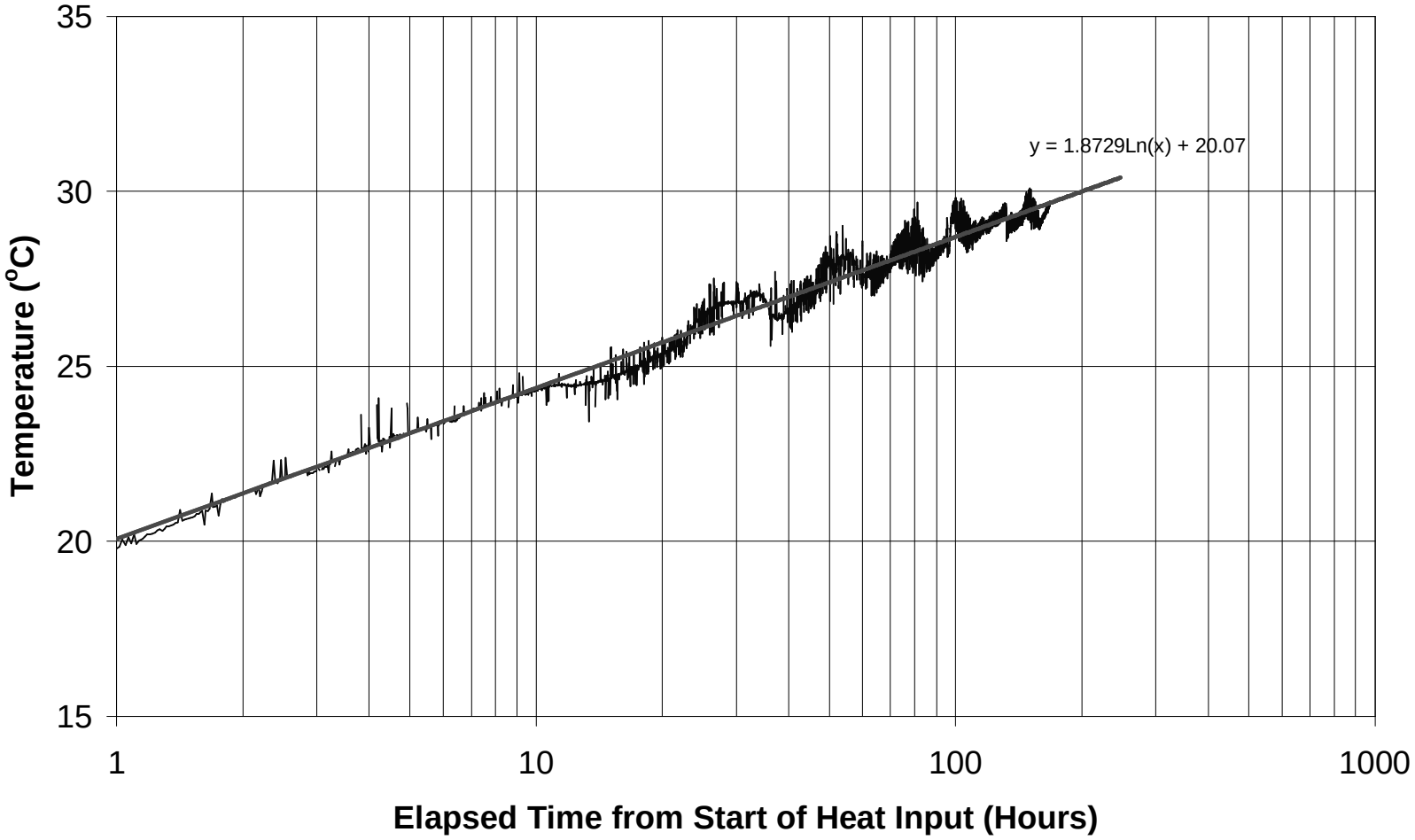
Thermal Response Testing Unit



Test Results



Test Results



Thermal Conductivity

- Thermal conductivity, λ can be calculated:

$$l = \frac{q}{4pk}$$

- Where: q is the constant heat injection rate

  k is the slope of the logarithmic plot of $(T_{IN}+T_{OUT})/2$ against time

- Giving a thermal conductivity of 1.8 W/m K

Client:	BAA Ltd
Consultant:	WSP Environmental Ltd
Principal Contractor:	WJ Groundwater Ltd
Drilling Sub-contractor:	Magpie Environmental Drilling Services Ltd