## Closed Loop Borehole System

# EXAMPLE GEOREPORT

for

EXAMPLE XYZ
26 Marris Lane
Whenley
Herefordshire
XW7 9AB

by

Carbon Zero Consulting
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October 2008

**LEGEND**

| | |
|---|---|
| mAOD | Metres above Ordnance Datum |
| mbgl | Metres below Ground Level |
| RWL | Rest Water Level |
| PWL | Pumped Water Level |
| TD | Total Depth |
| uPVC | Unplasticised Poly Vinyl Chloride |

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# GEOREPORT

## Information Supplied

Address: XYZ, 26 Marris Lane, Whenley,Herefordshire, XW7 9AB

Type of System: Closed loop
Peak heating load: 10kW

## Summary

- The required energy load has been estimated and should be confirmed by the client prior to construction of the borehole/s.
- Based on the assumptions given, the length of borehole required to meet the 10kW requirement will be 165m. It is recommended that two boreholes are drilled to a depth of 83m each and completed approximately 40m in to the top of the Chalk.
- The rest water level beneath the site is expected to be 65m below ground level.
- There is a general requirement to inform the BGS of the intent to drill a borehole greater than 15m in depth and supply the information to them.
- A contaminated land survey is beyond the scope of this report. It is recommended that an historical land use survey is undertaken in order to identify any potential sources of contamination or that any made ground encountered should be stored separately and appropriately before being removed from site and sent to a suitably licensed waste facility.

**John Findlay MSc CEng FGS**
Director

## Site Description (Figure 1)

- Elevation approximately 130mAOD on the crest of a hill which slopes gently towards the east.
- A small stream or drainage channel is shown 200m to the south east at 120mAOD
- A number of small ponds are present, the closest being 200m to the southwest at 133mAOD.

## Geology (Figure 2)

| ***Formation / Group*** | | ***Description*** | ***Expected Thickness*** |
|---|---|---|---|
| Superficial Deposits | Stanmore Gravel Formation | Sand and gravel with lenses of silty clay. | 10 - 15m |
| London Clay | | Fine, sandy, silty clay, glauconitic at base. | 10 – 20m |
| Lambeth Group | | Glauconitic fine-grained sands, clayey sands, and waxy clays with mottling. | 5 - 10m |
| Chalk | | White chalks (microporous coccolithic limestone) with beds of flint, nodular chalks, hardgrounds and marl seams. | >200m |

## Geological Structure

- There is no significant faulting on the site or in the local area.
- The strata are considered to dip gently towards the south east.

## Borehole Stability

There is the potential for running sand within the finer grained parts of the Lambeth Group; specifically the junction between the Lambeth Group and the underlying Chalk. The drilling contractor should be made aware of this.

## Hydrogeology

| | | |
|---|---|---|
| ***Groundwater Level*** | Estimated at 65 - 75mbgl. | |
| ***Aquifers*** | Superficial Deposits | Considered to be unsaturated. |
| | London Clay | Low permeability formation and therefore not considered in terms of aquifer potential. |
| | Lambeth Group | Minor Aquifer. Part of the Basal Sands Aquifer, small yields (0.1-1.9$m^3$/hr) can be obtained. Hydraulically connected with the chalk, although risks associated with construction and long term use of boreholes due to ingress of fines. |
| | Chalk | Major Aquifer. The top 30 - 40m provides the greatest inflow. Capable of providing yields in the region of 10 - 50$m^3$/hr. Fracture flow dependant. |

## Thermal Conductivity

| ***Formation / Group*** | ***Thermal Conductivity (W/mK)*** |
|---|---|
| Superficials | ~1.0 |
| London Clay | ~1.6 |
| Lambeth Group | ~1.6 |
| Chalk | ~1.7 |

- Average Thermal Conductivity (Harmonic Mean) excluding superficials: 1.6 W/mK

## BGS Records

One BGS Borehole (TQ19/69) has been reviewed and is summarised in the table below

| | |
|---|---|
| Location form site | 1km South west |
| Completion Depth | 93mbgl |
| Elevation | 120mAOD |
| Rest Water Level | 61.1mbgl |
| Yield | 0.625$m^3$/hr over 10 hours |
| Other comments | 1.9m Drawdown |

## Borehole Siting

No special considerations.

## Borehole Construction (Appendix A, Figure 3)

- It is recommended that 2 boreholes are drilled to a depth of 83m each. Drilling with mud flush is recommended

## Regulation

Consent and licence not required from the Environment Agency

**Discussion**

Geology based on readily available 1:50 000 scale maps (or nearest imperial equivalent)

In these systems a closed loop circulates a heat carrier fluid through an array of deep or shallow boreholes or piles, through horizontally trenched coils or through coils placed in the bed of a lake; where heat is either dumped (cooling mode) or absorbed (heating mode). Heat is transferred between the heat carrier fluid and the building environment by a heat pump. No water is abstracted and heat migrates to the ground from the borehole (or vice versa) dominantly by conduction.

The borehole length in this report has been calculated using our domestic closed loop design tool (Appendix B). This tool assumes that:

| | |
|---|---|
| Peak Load Ground Temperature | Does not drop below -5$^{o}$C |
| Winter Seasonal Load Ground Temperature | Does not drop below 0$^{o}$C |
| Average Annual Load Ground Temperature | Does not drop below 1$^{o}$C |
| Seasonal Performance Factor | 3.5 |
| Borehole Diameter (mm) | 150 |
| Undisturbed Ground Temperature ($^{o}$C) | 12 |
| Borehole Thermal Resistance (Km/W) | 0.22 |

In the UK, closed loop boreholes are normally drilled to a depth of 100m, apart from in locations where the geology or difficult ground conditions prevents it. Based on the assumptions given below, the length of borehole required to meet the assumed 10kW requirement will be 165m. Based on this assessment it is recommended that two boreholes are constructed to a depth of 83m each.

Further detailed analysis is unwarranted for this scale of development. It is considered that the assumptions made in the assessment, provide a conservative factor of safety.

Based on the information provided, consent to construct the borehole, will not be required from the EA as the proposed system is a closed loop system and therefore no abstraction will be undertaken. There is a general requirement to inform the BGS of the intent to drill a borehole greater than 15m in depth and to supply the geological information from the borehole to them.

A contaminated land risk assessment is beyond the scope of this report and it is recommended that an historical land use survey is undertaken prior to drilling. Alternatively, any made ground encountered could be considered contaminated, stored separately from any other spoil and sent to a suitably accredited waste disposal facility.

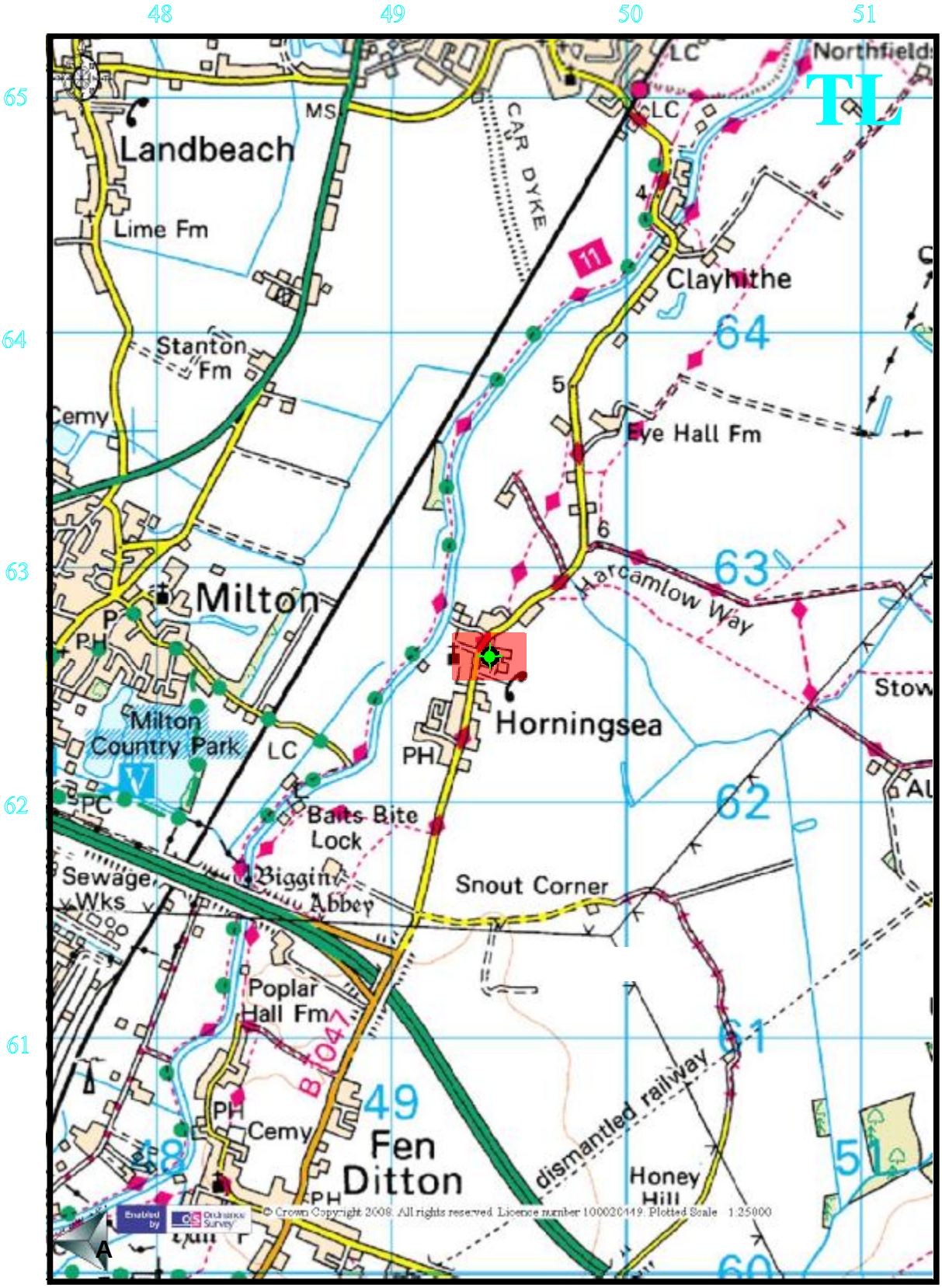
Development of boreholes has an inherent risk. Developers should be aware that it is possible that unforeseeable ground conditions may exist that result in increased development costs.

JDIH standard terms of engagement apply to this report. Copies can be supplied on request.

| ***Completed by*** | ***Date*** | ***Checked by*** | ***Date*** |
|---|---|---|---|
| AB | 14/10/08 | CD | 15/10/08 |

Our standard terms of engagement apply to this report. Copies can be supplied on request.

# Appendices




Site Location



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| | |
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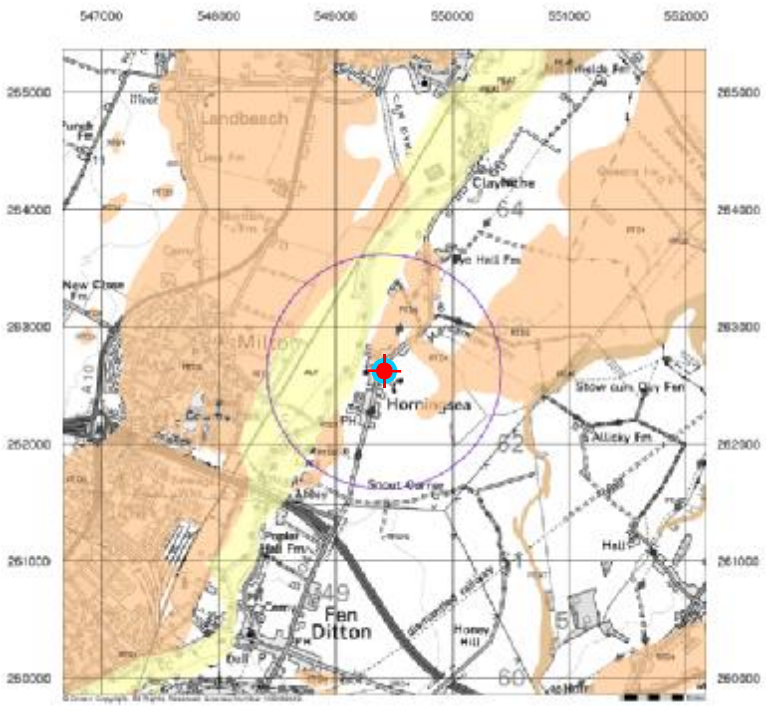
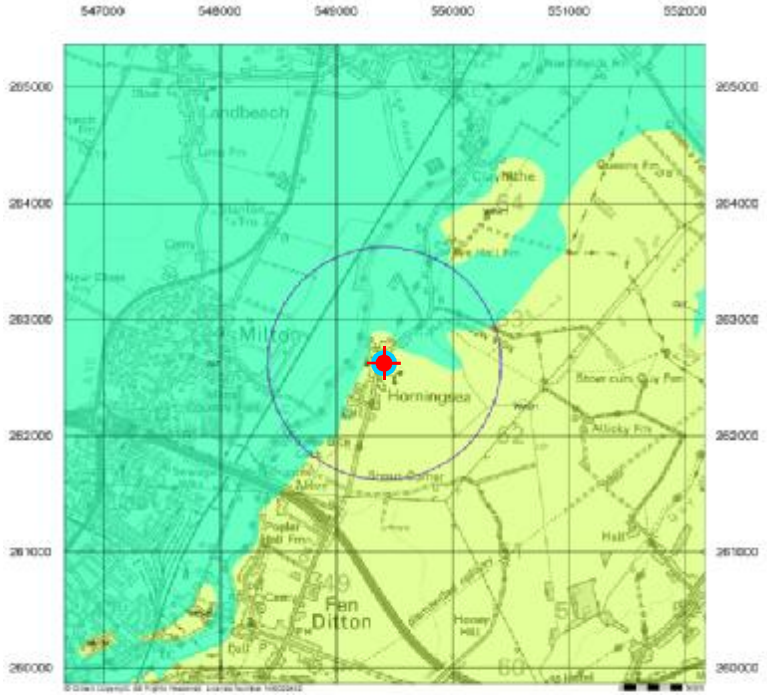
| Figure 1 | Site Location Plan |

## Superficial Geology




## Solid Geology




Alluvium

Peat

River Terrace Deposits

Site Location

West Melbury Marly Chalk Formation

Gault Formation

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Date: 18/12/08



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| Figure 2 | Geology |

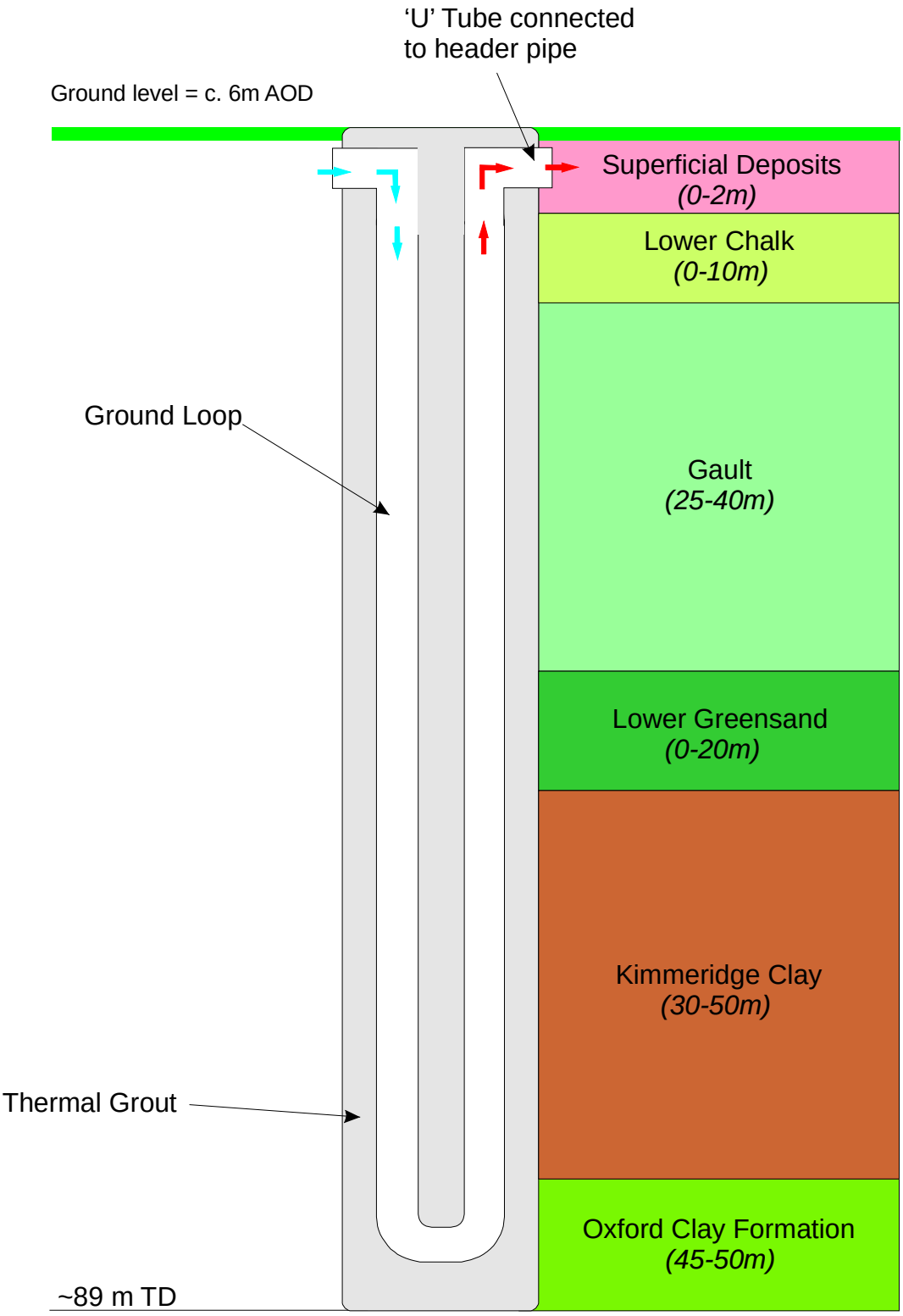


*Diagram assumes 2 boreholes to 89m to be drilled.*
*Alternative = 3 boreholes to 60m.*
*Diameters to be confirmed by drilling contractor*
*Depths may vary depending on the exact geology encountered*

| | |
|---|---|
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| Figure 3 | Closed Loop Borehole Schematic |

*Carbon Zero Consulting*

**Domestic Closed Loop Design Tool**

| **Input parameters** | | | |
|---|---|---|---|
| Heat Pump Capacity | 10 | kW | *(Invalid for systems >15kW)* |
| Seasonal Performance Factor | 3.5 | | *Assumption* |
| Borehole Diameter | 150 | mm | *Assumption* |
| Undisturbed ground temperature | 12 | °C | *Assumption* |
| Borehole thermal resistance | 0.11 | Km/W | *Assumption* |
| Thermal conductivity | 1.6 | W/m/K | |
| Borehole Length | 230 | m | |

| | |
|---|---|
| Client | |
| Project Name | |
| Project Number | 5778 |
| Analyst | AR |
| Checked by | |
| Date | 17/12/2008 |

| **Peak Load** | | |
|---|---|---|
| Heat extraction | 7143 | W |
| Borehole diameter | 150 | mm |
| Spec. heat capacity | 2400000 | J/m3/K |
| Thermal conductivity | 1.6 | W/m/K |
| t | 3 | days |
| Borehole length | 230 | m |
| Temperature at 25years | 6.43 | °C |
| Borehole thermal resistance | 0.11 | Km/W |
| q (W/m) | 31.06 | W/m |
| Thermal diffusivity | 6.67E-07 | m2/s |
| Temp drop in rock mass | 6.54 | °C |
| Temp drop at borehole | 3.42 | °C |
| **Temp. at time t + 25years** | -3.53 | °C |
| **Temp must not drop below** | **-5.00** | **°C** |

| **Winter Seasonal Load** | | |
|---|---|---|
| Heat extraction | 3274 | W |
| Borehole diameter | 150 | mm |
| Spec. heat capacity | 2400000 | J/m3/K |
| Thermal conductivity | 1.6 | W/m/K |
| t | 91 | days |
| Borehole length | 230 | m |
| Temperature at 25years | 6.43 | °C |
| Borehole thermal resistance | 0.11 | Km/W |
| q (W/m) | 14.23 | W/m |
| Thermal diffusivity | 6.67E-07 | m2/s |
| Temp drop in rock mass | 5.41 | °C |
| Temp drop at borehole | 1.57 | °C |
| **Temp. at time t +25 years** | -0.55 | °C |
| **Temp must not drop below** | **-1.00** | **°C** |

| **Average Annual Load** | | |
|---|---|---|
| Heat extraction | 1781 | W |
| Borehole diameter | 150 | mm |
| Spec. heat capacity | 2400000 | J/m3/K |
| Thermal conductivity | 1.6 | W/m/K |
| t | 9131 | days |
| Borehole length | 230 | m |
| Undisturbed temperature | 12 | °C |
| Borehole thermal resistance | 0.11 | Km/W |
| q (W/m) | 7.74 | W/m |
| Thermal diffusivity | 6.67E-07 | m2/s |
| Temp drop in rock mass | 4.72 | °C |
| Temp drop at borehole | 0.85 | °C |
| **Temp. at time t** | 6.43 | °C |
| **Temp must not drop below** | **1.00** | **°C** |

Assumed heating hours of building

| | | | | | |
|---|---|---|---|---|---|
| 11 | hrs per day for | 91 | days | (Winter) | 1783 kWh |
| 7 | hrs per day for | 91 | days | (Spring) | 1134 kWh |
| 7 | hrs per day for | 91 | days | (Autumn) | 1134 kWh |
| 3 | hrs per day for | 92 | days | (Summer) | 492 kWh |
| | Total | 365 | days | | 4543 kWh |
| | | | | Annual Average = | 1.781 kW |
| Maximum total of hours in year = | | 8766 | hrs | | |
| No. of hours utilised in year (given above) = | | 2551 | hrs | | |
| % of total hours = | | 29 | % | | |

| | | |
|---|---|---|
| **Lower compliance limit for valid approximation** | 42188<br>12 | seconds<br>hours |
| **Upper compliance limit for valid approximation** | 25<br>=ts/10 | years |
| **Time for steady state** | 7.85E+09 | seconds |
| ts | 90875 | days |
| | 249 | years |
| Temp drop in rock mass | 5.60 | °C |
| Temp drop at borehole | 0.85 | °C |
| **Steady State Temperature** | 5.54 | °C |