

Hyde Park Hayes – HPH5



ENERGY STATEMENT

- 02 July 2012



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1. Executive Summary

This Energy Statement has been developed to demonstrate how the Hyde Park Hayes (HPH5) 5 Office development at Hyde Park Hayes in Hillingdon will address local, regional and national planning requirements.

This Energy Statement has therefore been developed in line with the GLA Energy Hierarchy of “Be Lean”, “Be Clean”, and “Be Green” stages to design a low carbon building and maximise the use of low and zero carbon technologies. Although this Development does not meet the threshold for a Major Development for referral to the GLA, local planning policies have strong low carbon ambitions which follow GLA policies.

Be Lean

The scheme has been designed to include a number of passive and active design measures to reduce energy demand and carbon emissions to achieve a significant improvement on Part L of the Building Regulations (2010). Based on a Part L compliance assessment using IES <virtual environment> Compliance Thermal Modelling Software this building would achieve a Building CO₂ emission rate (BER) of 20.3 kgCO₂/m² against the Notional Part L compliant Target Emission Rate (TER) of 21.8 kgCO₂/m². This is an improvement of 7% on a baseline compliant building before the addition of clean or low and zero carbon technologies.

The following are the key passive and active energy efficiency measures that will be used within the building design to achieve this level of improvement on Building Regulations:

- Fabric and external glazing with excellent levels of thermal insulation
- Windows with low g-values to control heat loss and gain
- Passive solar control
- Low air permeability
- High efficiency light fittings with addressable control
- Photo sensing lighting controls in perimeter zone, with occupancy sensing throughout
- High level of BMS controls
- Thermal wheel heat recovery to recover both heat and cooling
- High efficiency boilers
- High efficiency chillers with free cooling
- Low Specific Fan Power for air handling units, fans and fan coil units
- Demand-controlled ventilation with CO₂ sensors



Be Clean

Due to high levels of fabric insulation and efficiency of building services HPH5 annual heating and hot water demand is not suitable for the inclusion of Combined Heat and Power (CHP) at the site.

The London Borough of Hillingdon has been contacted (with a response still pending) to explore the potential to link the Development with existing or planned heat loads or networks. Based on the DECC Heat Map, it is assumed at present that limited available heat loads or waste heat sources exist for the proposed development to connect into.

Suitable connections will be made at the building perimeter and the plant room to enable the heating plant to link with any potential suitable local heat network in the future that may produce low carbon energy.

Be Green

A detailed feasibility assessment has been undertaken to assess the potential to include low and zero carbon technologies within the building's design. This assessment has identified:

- **Solar Photovoltaic array** to cover 270m² of roof area which would reduce annual carbon emissions from the development by an additional 19 tonnes. This is a 3.3% reduction in carbon emissions from renewable sources from the total of regulated and unregulated emissions. Based on the renewable feasibility assessment it is considered that this reduction is as far as is practically feasible to achieve with the inclusion so low and zero carbon technologies.

The following technologies have also been assessed and considered not viable for the development for the following reasons:

- **Wind:** Being in a built up area close to the airport, large scale wind turbines are not considered suitable for this site. Studies have shown that small scale wind turbines in the urban environment do not perform well. It is recommended that annual, location specific wind measurements are taken for any sites on the roof of buildings that may be viable for building-integrated renewables. It is considered that this is the only way to determine the viability of turbines at this scale. As the building is yet to be constructed it is not considered this option is worth taking forward at this stage
- **Solar thermal:** Solar thermal technology could be viable for this building. However roof space is being maximised for the use of Photovoltaics as these provide greater and more cost effective carbon savings. As solar thermal could only reduce carbon emissions from the building by less than 1% it is considered solar PV is more suitable for this development.

- Biomass: Due to the relatively low heat demand and hot water demand (6% of total carbon emissions) at the site, it is not considered that biomass technology would be suitable. This is coupled with air quality concerns which are associated with the combustion of biomass fuel in this area. Therefore, for the relatively low carbon benefit from the biomass boiler against the air quality constraints this technology is not suited to this development.
- Ground Source heat pump (closed loop and open loop): A geology assessment has been undertaken for the site which has identified some contamination. The geologist report highlights that ground source (open or closed loop) may allow a path for contamination if deep boreholes are drilled on the site. This concern is coupled with limited external land available outside the development for boreholes and concerns of placing boreholes underneath the building structure. Furthermore, as the relative proportion of heating and cooling for the building is quite small and the ground source heat pumps are only slightly more efficient than a high efficiency condensing boiler and air cooled chillers - the carbon savings are relatively low at only 2%. For these reasons ground source heating is also not considered a viable technology for the site.

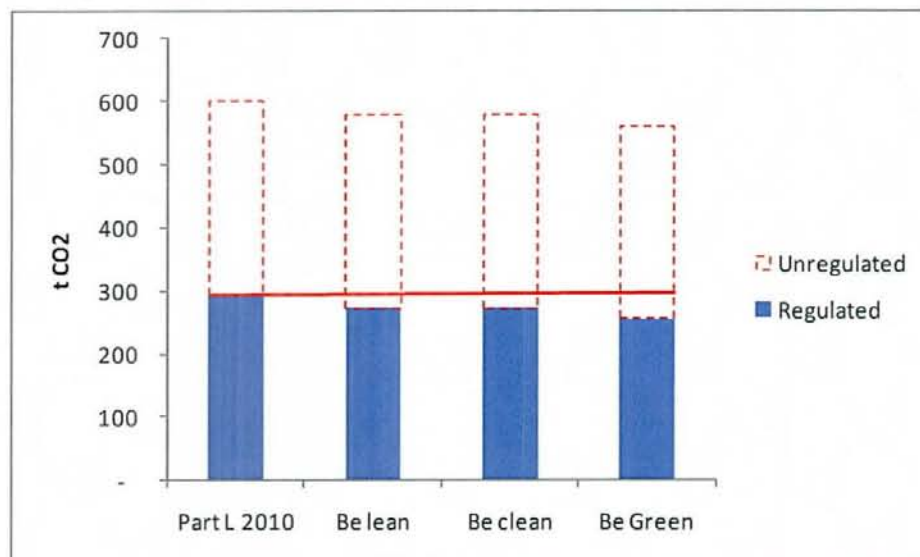
The following table highlights highlight the improvement over the baseline Building Regulation compliant building with unregulated emissions. This shows a **14%** improvement against regulated carbon emissions baseline and a **7%** improvement when unregulated emissions are included in the assessment.

■ **Table 1 Carbon Dioxide Emissions after each stage of the Energy Hierarchy**

	Carbon dioxide emissions (Tonnes CO ₂ per annum)			Improvement on Part L	Improvement on all emissions
	Regulated	Unregulated	Total	Percentage	Percentage
Building Regulations 2010 Part L Compliant Development	294	307	602	-	-
After energy demand reduction	274	307	581	7%	3%
After CHP	274	307	581	0%	0%
After renewable energy	255	307	562	6%	3%
Total Savings				14%	7%

The Figure below outlines the improvement on regulated and unregulated carbon emissions based on the Part L 2010 compliant building.

■ **Figure 1 Improvement on Regulated and Unregulated Emissions**



Carbon Fund

Following discussions with Hillingdon Council it has been outlined that it would be possible to contribute to a local carbon fund to achieve a full 25% reduction on regulated carbon emissions. The development is currently achieving a 14% improvement on Part L. As the example below shows, taking a lifetime of the building as 60 years and a current Carbon Reduction Commitment price per tonne of carbon (12£/tCO₂), an additional £24,296 could be payable to a carbon fund.

■ **Table 2 Cost to Achieve 25% Carbon Reduction**

Carbon Fund Payment	Unit	
Total baseline regulated carbon	t CO ₂	294
25% Improvement on Part L	t CO ₂	74
Development carbon reduction (14%)	t CO ₂	40
Additional CO ₂ reduction for 25%	t CO ₂	34
Lifetime of Building	Years	60
Cost per tonne of Carbon	£/t	12
Total cost	£	24,296

2. Introduction

This Energy Assessment has been prepared in support of the Application for Hyde Park Hayes-HPH5 office building. It aims to address the energy and climate change requirements of Hillingdon Borough Council and relevant policies on a regional and national level.

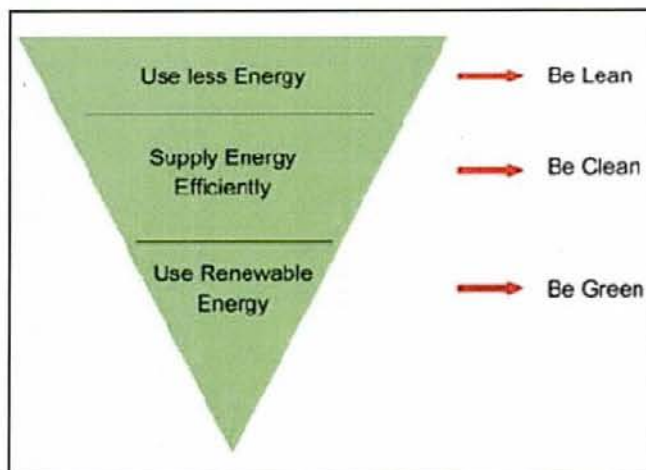
Following best practice and policies set out by Hillingdon the format of the statement is intended to reflect the GLA's London Plan.

This approach considers a hierarchy of energy and carbon reduction measures from a baseline position of regulated and unregulated carbon emissions. Regulated emissions include fixed systems such as heating, cooling, lighting, pumps and fans which constitute a Part L (2010) compliant building. Whilst unregulated emissions cover equipment energy, such as lifts and plug-in equipment, not regulated by Part L of the Building Regulations.

The hierarchy considers savings to reduce energy demand the most important, followed by efficient generation and finally low carbon technologies.

- “Be Lean” - Reduce the building’s energy requirements by incorporating passive design measures and reduce the building’s energy consumption through the use of energy efficient mechanical and electrical engineering systems.
- “Be Clean”- Reduce the building’s carbon dioxide emissions through the supply of heat and electricity delivered by Combined Heat and Power (CHP).
- “Be Green” - Reduce the building’s carbon dioxide emissions through the use of renewable technologies.

■ **Figure 2 GLA Energy Hierarchy**





This assessment has been undertaken using the following methodology:

- **Be Lean:** Detailed assessment of mechanical and electrical designs within IES Thermal Modelling Software to demonstrate compliance and improvement over Building Regulations (2010). This modelling also provides the baseline regulated carbon emissions based on the Notional Building which is Part L compliant and also data on unregulated carbon emissions.
- **Be Clean:** An assessment of the feasibility of CHP and tri-generation based on the annual heating and cooling demand from the development, alongside a review of potential sources of waste heat in the local area in order to connect the site now or in the future.
- **Be green:** A detailed assessment of low and zero carbon technologies based on the annual energy profile of the proposed development and local opportunities and constraints presented by the building's form and location.

3. Policy Context

Energy efficiency and reduced carbon emissions for new buildings is being driven by Part L of the Building Regulations (2010) and planning policy.

3.1. Building Regulations

The 2006 amendment to Part L of the Building Regulations was driven by the need to adopt a methodology for calculating the energy performance of buildings as called for by the EU Energy Performance of Buildings Directive (EPBD). In 2010 these higher design standards for non-domestic buildings were tightened to a further aggregate 25% improvement on 2006 levels. The Government is consulting on how this level should be further tightened in 2013 towards zero carbon non-domestic new buildings by 2019.

3.2. National Policy

3.2.1. National Planning Policy Framework

The National Planning Policy Framework was published on 27 March 2012. The majority of the Planning Policy Guidance Notes were cancelled with the publication of the National Planning Policy Framework. This Framework sets out guidelines to enable Local Authorities to set policies to enable climate change mitigation and adaptation from new developments.

3.3. Regional Policy

3.3.1. The London Plan – Greater London Authority

The London Plan is the overall strategic plan for London, and it sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031. It forms part of the development plan for Greater London. London boroughs' local plans need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor. Key relevant energy and carbon emission policies include:

Policy 5.2 Minimising carbon dioxide emissions

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

- Be lean: use less energy
- Be clean: supply energy efficiently
- Be green: use renewable energy

The Mayor will work with boroughs and developers to ensure that major developments for non-domestic buildings meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Year	Improvement on 2010 Building Regulations
2010-2013	25%
2003-2016	40%
2016-2019	As per building regulations
2019-	Zero Carbon

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

- As a minimum, energy assessments should include the following details:
 - a calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy;
 - proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services;
 - proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP); and
 - proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash-in-lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

3.4. Local Policy

3.4.1. London Borough of Hillingdon Unitary Development Plan

The London Borough of Hillingdon's Unitary Development Plan was originally adopted in 1998.

Following the Secretary of State's decision in August 2006 and a direction issued on 24 September 2007 by the Government Office for London, Hillingdon's request to 'Save' key local policies was approved. This was effective from the 27 September 2007.

Saved policies in Hillingdon's UDP will gradually be replaced by policies in Hillingdon's Local Development Framework documents. The Core Strategy is the first of these documents, and once adopted will replace some of the saved policies.

In terms of energy policies in the UDP, in the interim period the London Plan policies should be followed.

3.4.2. LDF Core Strategy Development Plan

The council submitted the LDF Core Strategy Development Plan Document to the Secretary of State (for Communities and Local Government) for independent examination on 31 October 2011.

The LDF has 6 strategic objectives; one of these is related to climate change:

SO11: Address the impacts of climate change and minimise emissions of carbon and local air quality pollutants from new development and transport.

Policy EM1: Climate Change Adaptation and Mitigation

Policy EM1 below includes criteria that need to be considered throughout the development of the LDF. The subsequent Site Allocations DPD and Development Management DPD along with any future SPD's must accord with the overarching principles of this policy. Relevant policies are outline below:

- The Council will ensure that climate change mitigation is addressed at every stage of the development process by:
 - Ensuring development meets the highest possible design standards whilst still retaining competitiveness within the market.
 - Working with developers of major schemes to identify the opportunities to help provide efficiency initiatives that can benefit the existing building stock.
 - Promoting the use of decentralised energy within large scale development whilst improving local air quality levels.



- Targeting areas with high carbon emissions for additional reductions through low carbon strategies. These strategies will also have an objective to minimise other pollutants that impact on local air quality. Targeting areas of poor air quality for additional emissions reductions.
- Encouraging the installation of renewable energy for all new developments in meeting the carbon reduction target savings set out in the London Plan. Identify opportunities for new sources of electricity generation including anaerobic digestion, hydroelectricity and a greater use of waste as a resource.
- Promoting the inclusion of passive design measures to reduce the impacts of urban heat effects.

4. Baseline Energy and Carbon Emissions

IES thermal modelling Dynamic Simulation Software (DSM) has been used to determine the energy and carbon emissions baseline of the new office design.

The baseline is determined from the Notional Building under Part L of the Building Regulations (2010). This provides the annual energy consumption and carbon emissions resulting from the Target Emissions Rate (TER) measured in kgCO_2/m^2 . This provides the baseline annual 'regulated' carbon emissions from the Building Regulations.

Additional 'Unregulated' carbon emissions are calculated based on the figure for additional equipment energy and carbon emissions which are not considered as part of the Part L assessment. This energy and emissions is calculated but not included as part of the Part L assessment.

■ **Table 3 Baseline Energy Consumption (Part L 2010 Compliant)**

Regulated					Unregulated
Space Heating (kWh)	Domestic Hot Water (kWh)	Chillers (kWh)	Pumps and Fans (kWh)	Lights (kWh)	Equipment (kWh)
189,650	40,075	43,986	174,096	263,569	594,687

■ **Table 4 Baseline Carbon Emissions**

	Regulated (tCO ₂)	Unregulated (tCO ₂)	Total (tCO ₂)
Baseline Building	294	307	602

5. Be Lean – Energy Efficiency

The Energy Statement for Hyde Park Hayes has taken a three-stage – be lean, be clean and be green - approach to reducing the building's carbon emissions.

In this section we outline the passive and active measures to reduce energy demand from the building design. This is the first step of the energy hierarchy. Reducing energy demand is an important first step before considering alternative methods of supplying energy to a building.

A number of measures will be included within this building's design in order to meet and exceed Part L of the Building Regulations. Without details of how the building will be used in operation at present it is not possible to impact on unregulated emissions.

Some of the key measures that will be specified to reduce energy demand for this development include:

- Low u-values throughout (wall 0.2, roof 0.15, floor 0.18, glazing 1.6) W/m²K
- Windows with low g-values to control heat loss and gain
- Passive solar control
- Low air permeability
- Passive solar control
- High efficiency tubular fluorescent light fittings
- Lighting occupancy control
- Lighting photo sensors by windows
- Building Management System with Zoning and Temperature Control
- Recovery of heat and cooling
- High efficiency condensing boilers
- High efficiency chillers
- Low Specific Fan Power for air handling units, fans and fan coil units
- Demand controlled ventilation with CO₂ sensors

A very efficient building has been designed that combines the building architecture with efficient building service design and specification. Based on a Part L calculation this building would exceed the building regulations by a **7% improvement** on a notional building.

■ **Table 5 HPH5 Energy Consumption**

Regulated					Unregulated
Space Heating (kWh)	Domestic Hot Water (kWh)	Chillers (kWh)	Pumps and Fans (kWh)	Lights (kWh)	Equipment (kWh)
96,751	46,560	78,776	144,453	250,903	594,687

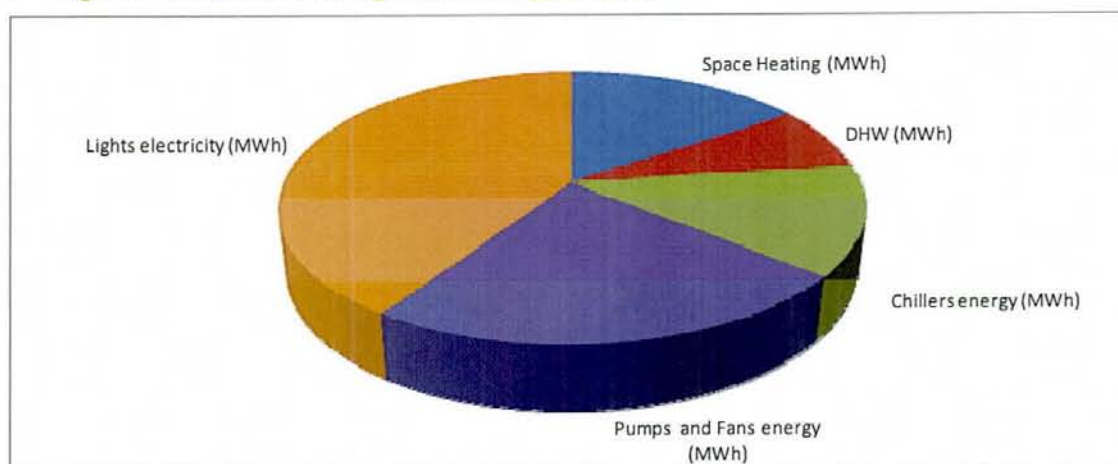
The following table shows the energy consumption converted to tonnes of Carbon Dioxide using the carbon factors outlined in Standard Assessment Procedure (2010).

■ **Table 6 HPH5 Carbon Emissions**

	Regulated (tCO ₂)	Unregulated (tCO ₂)	Total (tCO ₂)	Improvement on Part L	Improvement Total CO ₂ emissions
Baseline Building (TER)	294	307	602	-	-
HPH5 (BER)	274	307	581	7%	3%

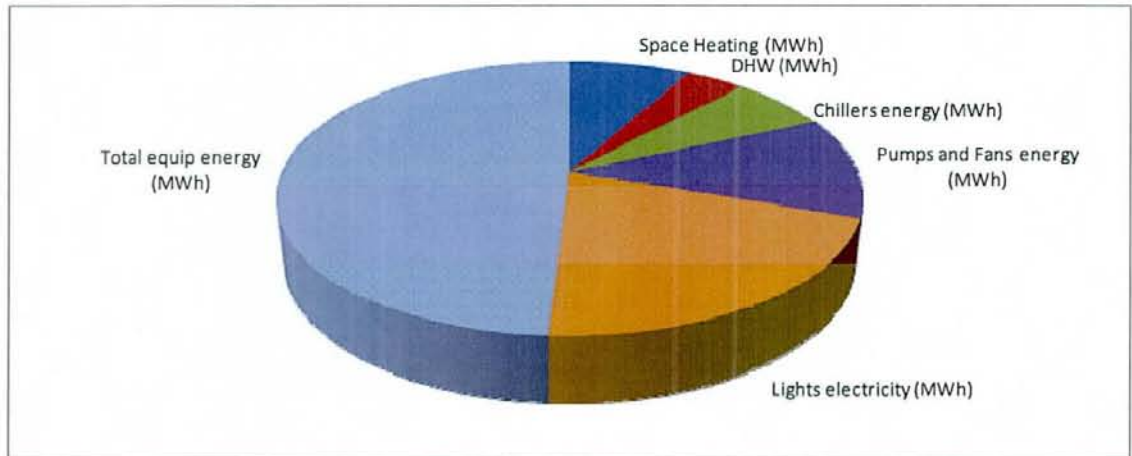
The Figures below show how energy demand by end use is divided for regulated energy and unregulated energy. Due to high levels of thermal insulation from the building fabric and efficient services design, the heating and cooling demand is only a relatively small proportion of the total energy demand.

■ **Figure 3 Breakdown of Regulated Energy Demand**



Unregulated energy and emissions account for around half of the total building energy demand. This energy and carbon cannot be affected by building design, but has a large impact on the overall carbon emissions and the availability of technologies to further reduce emissions from clean and renewable sources.

■ **Figure 4 Breakdown of Regulated and Unregulated Energy Demand**



6. Heating and Cooling Infrastructure including CHP (Be Clean)

6.1. District Heating and Cooling

The second step in the GLA carbon hierarchy is to consider opportunities for carbon reduction from clean technologies. This means evaluating the potential for using district or community heating schemes that use more efficient technologies such as Combined Heat and Power (CHP) and also trigeneration, which utilises heat from the CHP in summer for cooling.

District or community heating can have a number of benefits:

- **Resource Efficiency:** Where sources of usable waste heat exist in the area - such as from industrial plants and energy from waste plants – this reduces the overall use of resources to generate energy.
- **Energy efficiency:** Usually district heating is more energy efficient, due to simultaneous production of heat and electricity in combined heat and power generation plants. Furthermore a larger central plant can also be more efficient than many small plants and reduce energy consumption.
- **Carbon Emissions:** A district heating network will reduce CO₂ emissions through optimisation of heat supply. Central plants also employ stringent emission controls in comparison to individual buildings which will provide air quality benefits.
- **Fuel Cost Savings:** Savings from bulk fuel purchasing and higher efficient plants of district heating networks can be passed onto the community through lower fuel charges.

The potential to link with existing or planned energy sources/heat loads or networks have been raised with the Council as part of the design. From an assessment of the area it does not appear that suitable energy sources or waste heat sources exist for the proposed development to connect into.

The Department of Energy and Climate Change (DECC)¹ has developed a heat map of the UK to provide an indication of the viability for district heating and CHP in an area. The Figure below highlights that the Development is in a location that does not have a particularly high heat load 5000-10,000 kWh/m² and may not be a suitable location for a district heating network.

¹ <http://chp.decc.gov.uk/developmentmap/>

■ Figure 5 DECC CHP Heat Map



The potential to link with existing planned heat loads or networks has been raised as part of the design. However, at present it is unlikely that available loads or waste heat sources exist for the proposed development to connect to.

Suitable connections points will be made in order to enable the heating plant to link with any potential suitable local heat network in the future that may produce low carbon energy.

6.2. HPH5 Combined Heat and Power

Where sources of waste heat and/or district heating may not be currently viable or available for a new development it may still be feasible to specify clean technologies at the building site level. Where suitable, a CHP will be more efficient than providing separate heat and power at the site by conventional means. However, a relatively large annual heat load needs to be available at a site to make combined heat and power viable.

Due to high levels of fabric insulation and efficiency of building services HPH5 calculations show that annual heating and hot water demand is not sufficiently suitable to cost effectively include Combined Heat and Power (CHP) at the site.

7. Renewable Energy Sources (Be Green)

The Mayor's London Plan and the London Renewables Toolkit consider the following renewable and low carbon technologies as being acceptable for supplying a proportion of a site's energy demand. These are considered to potentially be the most likely options for developments in London:

- Wind Turbines
- Solar Thermal
- Solar Photovoltaics
- Biomass Heating
- Ground Source Heat Pumps – Closed Loop, Open Loop

The feasibility of each of the energy sources listed has been assessed with regards to the potential contribution each could make to supply a proportion of the development's delivered energy requirement, whilst considering the technical, planning and financial issues.

7.1. Wind Turbines

Wind Energy is indirectly created by the sun as movements of air are caused by differential solar heating of the Earth's atmosphere. Wind technology harnesses the power of kinetic energy in the wind and converts it into electrical energy.

The performance of a wind turbine depends largely on the available wind resource in terms of wind speed and occurrence. It is essential that turbines should be sited away from obstructions, with a clear exposure or fetch for the prevailing wind.

7.1.1. Large stand-alone wind turbines

Located in an urban environment with buildings within close proximity a turbine would need to be taller than the surrounding buildings to access sufficiently high wind speeds to be viable. Stand alone wind turbines also need to have sufficient topple distance from buildings and local infrastructure (e.g. roads, electricity transmission cables) to reduce the risk of any accidents. As turbines can interfere with radar systems, being close to Heathrow airport would increase the planning complexity for wind turbines at this site. For these reasons it is not considered that a large stand alone wind turbine would be viable for this site.

■ **Figure 6 Large Scale Wind Turbine**



7.1.2. Small building-integrated wind turbines

It is not recommended to install small-scale building-integrated renewable technologies within the urban environment. Average annual wind speeds in the area are at 4.9m/s, 5.6m/s and 6.1m/s at 10m, 25m and 45m above ground level (agl) respectively. However, due to the impact of the urban environment, the outputs of building integrated turbines are low. A study undertaken in Warwick University² covering 168,950 hours of operation of 26 building mounted wind turbines (at a level of 45m agl) from five manufacturers across the UK during 2007-2008 found a capacity factor (i.e. time when the turbine as at maximum operation) was 0.85% when it would be expected to be closer to 20-25%.

It is recommended that annual, location specific wind measurements are taken for any sites on the roof of buildings that may be viable for building-integrated renewables. It is considered that this is the only way to determine the viability of turbines at this scale. As the building is yet to be constructed it is not considered this option is worth taking forward at this stage.

7.2. Solar Thermal

Solar thermal collectors convert solar radiation into thermal energy, which is used to heat water. Direct sunlight provides the most efficient energy collection, but solar heating is still effective on cloudy days. Solar thermal technology is widely available and is, in many situations, the most cost effective form of onsite renewable energy generation in the UK. Solar thermal technology has very low maintenance, and can reliably provide 50% or more of a building's hot water requirements, depending on demand and the size of system installed.

² www.warwickwindtrials.org.uk/resources/Warwick+Wind+Trials+Final+Report+.pdf

Solar thermal collectors are modular and either 'building integrated', i.e. forming part of a cladding system, or 'bolt on'. Arrays are typically pitched at about 30° and orientated between southeast and southwest and it is important that overshadowing is avoided. The two main types of solar collector are flat plate and evacuated tubes, with evacuated tubes being slightly more efficient but also more expensive.

■ **Figure 7 Solar Thermal**



Determining the size and timing of the annual hot water demand is a key issue in assessing the viability for solar thermal. Further technical considerations include having a suitable orientation of the roofs (ideally south facing) and connection to the specified hot water system. The table below outlines a feasibility assessment for solar thermal technology at HPH5.

■ **Table 7 Solar Thermal Feasibility Assessment**

Solar thermal	Units	
Annual hot water demand	kWh pa of Fuel	46,560
Half hot water gas	kWh pa of Fuel	23,280
Estimated useable roof area	m2	270
Matching half hot water	m2	58
Matching half hot water	kW	41
Fuel used (pump) Used Energy	kWh pa of electricity	233
Operating costs	£	100
Gas savings	£	947
RHI Savings	£	2,072
Total savings	£	2,687
Capital cost	£	43,650
Payback	Years	16
Saving	t CO2 pa	4
Renewable Saving	% of total CO2	1%

Solar Thermal Summary

Solar thermal technology sized to provide half the hot water load for the building would require approximately 58m² of roof area. This would reduce overall carbon dioxide emissions by 0.8% from the total regulated and unregulated emissions.

Including an annual income from the Renewable Heat Incentive, a simple payback of around 16 years would be expected from this technology.

In conclusion solar thermal technology is a viable technology for this building. However, due to the relatively small proportion that domestic hot water constitutes towards total carbon emissions the impact would be a small reduction in carbon emissions. It is recommended this technology is considered unless available roof area is used for a more viable renewable technology.

7.3. Solar Photovoltaics

Photovoltaic cells are used to convert solar radiation into Direct Current (DC) electricity. The DC electricity is then inverted to AC electricity for use in buildings or for export to the grid.

Crystalline silicon cells (Monocrystalline or Polycrystalline) are the most common type of PV used in the UK and are becoming relatively cost effective with the growth of the PV sector. There are also thin film technologies such as amorphous silicon cells, which can be deposited on a wide range of substrates, both rigid and flexible, making it ideal for curved surfaces. Thin film technologies are generally slightly less efficient than other types of PV technology.

■ Figure 8 Solar PV



Solar Photovoltaic (PV) technology is not directly related to any specific building fabric element or service. They therefore allow for reasonable flexibility in their sizing subject to certain constraints,

the most important being surface area (roof or facade) and whether over shading is likely to occur. Similar to Solar Thermal technology, PV is constrained by the orientation of the roof or facade and also the amount of surface area available. PV requires a significant amount of roof area to achieve any real carbon reduction.

In terms of operation once installed, PV arrays require minimal maintenance over their operational life and have no primary fuel requirements.

The table below outlines a feasibility assessment for solar thermal technology at HPH5.

■ **Table 8 Photovoltaics Feasibility Assessment**

Photovoltaics	Units	
Roof area available	m2	270
Size	kW	35
Annual output	kWh	35,697
Electricity used on site	%	100%
Savngs from Supply	£	4,284
Savings with used elec FIT	£	5,426
Capital cost	£	105,115
Operational Costs	£	1,051
Total Savings	£	8,658
Payback on Capital	yrs	12
Saving	t CO2 pa	19
Renewable Saving	% of total CO2	3%

Solar PV Summary

As electricity demand is the dominant load at this site, a solar photovoltaics array can be sized to cover the maximum available roof area. It has been calculated that approximately 270m² of roof area is available which could provide space for a 35kW peak PV array.

With income from the Government's Feed in Tariff at 15.2 p/kWh, the simple payback for installing this technology is estimated as 12 years. (It is worth noting that this tariff is likely to decrease from August 2012). This would reduce annual carbon emissions by 19 tonnes, which is a 3% reduction on combined regulated and unregulated emissions.

A solar PV array would be suitable for this site. Total available roof area can be used to maximise the available power from PV. Horizontal placing designs will be considered at detail design of the PV array in order to maximise the output of the array.



Mono and Polycrystalline silicon types are considered most suited to this building. Thin film technologies for roof and glazing are not considered viable at this stage due to significantly reduced efficiency of this technology.

7.4. Biomass Heating

The term “biomass” refers to any material derived directly or indirectly from plant or animal matter. Therefore, biomass fuels can be derived from a number of sources such as wood from forestry, urban tree pruning, agricultural residues and specially grown crops for energy (energy crops). Biomass fuel is considered a renewable fuel, however it has some related CO₂ emissions due to processing and transport of the fuel.

Current biomass heating systems are highly controllable using programmable timers, room or zone thermostats and can be incorporated into building management systems (BMSs). However, there are a number of features and attributes of biomass heating that are different from either gas or oil which need to be considered such as fuel storage, accessibility, increased size, cost, and loading efficiency and fuel delivery logistics.

- Building space and organisation to accommodate and operate the plant.
 - Sufficient space needs to be provided to accommodate fuel storage. It is also important to ensure there is outside access to the fuel storage area and plant room. Auger routes connecting the boiler to the fuel store need careful consideration.
- Fuel Supply
 - Regular fuel deliveries would be required to operate the plant. The impact on the local road networks and possible congestion associated with the delivery of the biomass fuels needs to be assessed. Frequency of deliveries is a function of the fuel size.
- Air Quality
 - Biomass exhausts can have an impact on local air quality and require significant treatment to avoid degrading local air quality. Biomass boilers have higher NO_x and SO_x emissions than gas-fired boilers. Local Clean Air Act Regulations need to be considered.
- Heat Demand
 - Biomass as an energy source is not suitable where there are large fluctuations in thermal loads (unless sufficient, often large scale thermal storage is built into the heating system). Biomass boilers operate most efficiently when run at a constant rate with no or little throttling down of the output,

The Table below provides an overview of the feasibility assessment for biomass boiler at the site.

■ **Table 9 Biomass Boiler Feasibility Assessment**

Biomass Boilers	Units	
Boiler Size	kW	75
Hours run	h	1,500
Total heat produced	kWh	112,500
Total Fuel consumption	kWh	130,814
Total fuel used	kg	50,313
Total fuel used	tonnes	50
Capital cost not in container	£	36,000
Gas Cost Savings	£	4,578
RHI Tier 1 Savings	£	8,180
RHI Tier 2 savings	£	293
Biomass Fuel Cost	£	6,449
O&M costs	£	1,080
Annual savings/costs	£	5,522
Payback	Years	7
CO2 saving	tonnes	22
Renewable Saving	% of total CO2	4%

Biomass Summary

Where suitable, biomass boilers can provide a cost effective method to reducing carbon emissions. Due to the high levels of thermal efficiency specified in the building fabric and efficient plant the annual proportion of carbon emissions related to heating and hot water for HPH5 is only 6% of the total carbon emissions. As a result, a 75 kW sized unit utilised during the winter months would realise a 4% carbon saving from the site.

The payback of the technology is relatively good with the Government Renewable Heat Incentive providing 8.3p/kWh for the first 1,314 hours and 2p/kWh for every kWh of heat produced thereafter.

However, it is not considered that biomass technology would be suitable due to the low heat demand at the site. This is coupled with air quality concerns which are associated with the combustion of biomass fuel. It is therefore considered that for the relatively low carbon benefit from the biomass boiler against the air quality constraints this technology is not suited to this development.

7.5. Ground Source Heat Pumps

Ground source heat pumps utilise either water extracted from an aquifer (open loop) or water circulated within underground pipe work (closed loop) as the heat source in a refrigeration process enabling them to produce hot water, typically at around 45°C, that can be used as a heating medium in buildings. The technology relies on the stable temperature of the ground of between 10 and 14°C.

Ground or water based cooling exploits the thermal energy held within the ground and the improved thermal transfer properties of water to provide a more efficient heat pump than using the heat transfer medium of air.

Maximising efficiency of the GSHP system is achieved by correctly sizing the unit and any ground or water-coupled component of the system. It is the high Coefficient of Performance (COP) of a Heat Pump that maximises savings in operational costs.

Appendix A provides a desk based hydro geological assessment for the site, which gives an indication of the suitability of the ground conditions for open and closed loop heating.

7.5.1. Open Loop Ground Source Heating

In open-loop systems, groundwater is abstracted at ambient temperature from one or more abstraction boreholes, passed through heat exchangers and or heat pumps before being discharged back into the aquifer through one or more injection borehole(s). The water will have undergone a temperature change and the discharged water will be cooler (if used for heating of the building) or warmer (if used for cooling of the building).

The geological assessment (Appendix A) identified two aquifers beneath the site that would potentially support an open loop ground source heating and cooling system. These are considered in turn below.

Lynch Hill Gravels: Groundwater is known to be present approximately 5m below ground level (bgl) with an anticipated flow direction towards the south west. The gravels are only present in the western half of the site.

The potential sustainable abstraction rate from the gravel aquifer is not known, however, the potential exists for permeability of gravels to be limited by presence of clay, silt or fine sand. Gravels are only present in west of site and consequently it may not be possible to achieve a sufficient spacing between the abstraction and discharge boreholes to avoid the risk of thermal

breakthrough occurring. Moreover, the absence of gravel strata in east of site may limit the amount of groundwater that can be abstracted from the upstream borehole. A risk exists that the Environment Agency may not provide a licence for abstraction of groundwater from the gravels. This is due to the potential for the abstraction of the water to influence the migration of elevated concentrations of contaminants known to be present in groundwater beneath the site. Abstraction of significant volumes of water from the gravels could also potentially lead to localised settlement.

The groundwater flow direction is not known which will require an intrusive investigation to determine borehole location and viability. The productivity of chalk can also be variable due to fracture controlled groundwater flow. Design of abstraction and injection boreholes would have to eliminate the potential for the boreholes to create a pathway for contaminated water within the Lynch Hill Gravels to migrate downward to the Chalk aquifer, and this may require an increased liaison with the Environment Agency in relation to this issue. The cost of pumping will be greater than from the gravels. There is a risk of rapid water migration between discharge and abstraction boreholes if numerous fractures are present in the chalk.

Open Loop Ground Source Heating Summary

Although two potential aquifers are available at differing depths at the site, a design risk influencing the migration of elevated concentrations of contaminants known to be present in groundwater is a primary reason this option is not feasible at the site.

A further risk with open loop heating and cooling systems is that without significant preliminary assessment, the output of the boreholes is unknown. This risk is exasperated for open loop systems as the ground water may well vary throughout the year and into the future with predicted warmer and drier summers. For these reasons open loop ground source heating and cooling appears unlikely to be viable for this site.

7.5.2. Closed Loop Ground Source Heating

A closed loop system comprises a sealed pipe network buried within the ground through which water is continuously circulated. Loops can either be placed in purpose drilled boreholes, which are usually around 100m in depth or within the building piles.

A closed loop ground source system does not impact the groundwater resource itself, as it does not change natural sub-surface water flow, and as such is not directly regulated by the Environment Agency. However, pollution caused directly or indirectly by a closed loop scheme would still come within the remit of the environmental regulators e.g. pollution caused by a leaking system or the cross-connection of two aquifer units. This can be somewhat mitigated by the use of modern 'continuous pipe' loops where joints are restricted to accessible locations.

The viability of closed loop heat pumps systems is dependent on a number of issues:

- Demand for heating/cooling and associated annual profiles
- Cost/carbon emissions of gas/electricity being offset
- Ground area available for boreholes

The feasibility assessment below shows the potential costs and carbon savings for installing 15 closed loop boreholes to a depth of 100m under the building footprint or around the perimeter of the site. This low number reflects the relatively low annual heating and cooling demand for the building. The use of building energy piles has not been included in this assessment as there is concern in the industry at present about the impact on the building structure and designing energy piles to work in conjunction with deeper bore holes.

■ **Table 10 Closed Loop Ground Source Heating Feasibility Assessment**

Biomass Boilers	Units	
Number of Boreholes		15
Length of Boreholes	m	100
Heating output	kW	75
Cooling output	kW	75
Heating run hours	hours	1,000
Cooling run hours	hours	1,000
Annual heating output	kWh pa	75,000
Annual cooling output	kWh pa	75,000
Heating COP	COP	4.5
Cooling COP	COP	4.5
Gas Savings	kWh pa	87,209
Electricity chiller savings	kWh pa	21,429
Gas cost savings	£ pa	3,052
Electricity costs savings	£ pa	2,571
RHI Savings	£	3,525
GSHP Electricity consumption	kWh pa	33,333
GSHP electricity costs	kWh pa	4,000
Total cost saving	£ pa	5,149
Capital cost	£	120,000
Payback	years	23
Saving	t CO2 pa	11
Renewable Saving	% of total t CO2 pa	2%

Closed Loop Ground Source Heating Summary

The feasibility assessment shows that 15 boreholes could meet baseload heating and cooling demand of the building with peak loads supplied by boilers and chillers. As the relative proportion of heating and cooling for the building is quite small and the ground source heat pumps are only marginally more efficient than a high efficiency condensing boiler and air cooled chillers the carbon savings are relatively low at only 2%. There are structural engineering concerns surrounding installing boreholes below the building footprint. Engineers highlight that the weatherproofing of the basement would be compromised if the ground source system had a problem and had to be accessed. Furthermore, as this site is also maximised for space it will be challenging to place more than a few boreholes outside the footprint of the building.

Risks of contamination spread have been raised in the hydrogeology report (Appendix A) for both open and closed loop heat pump systems.

It is therefore concluded that, due to the risks of spreading ground water contamination, low carbon benefit of the system, the minimal space for installing boreholes and the additional cost and complexity of additional plant, the closed loop ground source heating is not a viable option for the site.

7.6. Renewable Feasibility Assessment Summary

The Table below highlights an overview of the feasibility assessment of the key technologies considered suitable for development.

Wind turbines, Combined Heat and Power and open loop GSHP have not been included in this table as these have been found to be unsuitable for further assessment.

■ **Table 11 Renewable Feasibility Summary**

Technology	Size (kW)	Carbon Saving (tCO ₂)	Renewable Saving (%)	Cost (£)	Payback (yrs)	Key Constraints
Solar Thermal	41	4	1%	86,625	16.2	Potentially feasible but low hot water demand therefore contribution is limited
Photovoltaics	35	18	3%	105,115	12.1	Electrical demand for building is high. Roof area can be maximised for PV
Biomass	80	32	5%	38,400	6	Low relative heat demand so contribution is limited. Air quality concern for the area.
GSHP - Closed Loop	5	11	2%	120,000	23	Space available is limited and concern over ground and water contamination



In summary Solar Photovoltaics is the preferred renewable technology for the site, which will further reduce emissions by 3% from the “be lean” baseline.

■ **Table 12 Carbon Reduction from Renewable Technologies**

	Regulated (tCO ₂)	Unregulated (tCO ₂)	Total	Improvement on Part L	Improvement Total CO ₂ emissions
Be Clean Baseline	274	307	581	-	-
Addition of renewable technologies	255	307	562	6%	3%

8. Conclusion

The development has been designed to follow the GLA energy hierarchy “be lean, be clean and be green”. It has been designed to meet high levels of energy efficiency and to minimise energy demand. It has reviewed the benefit of decentralised energy and CHP and maximised the use of renewable energy where feasible.

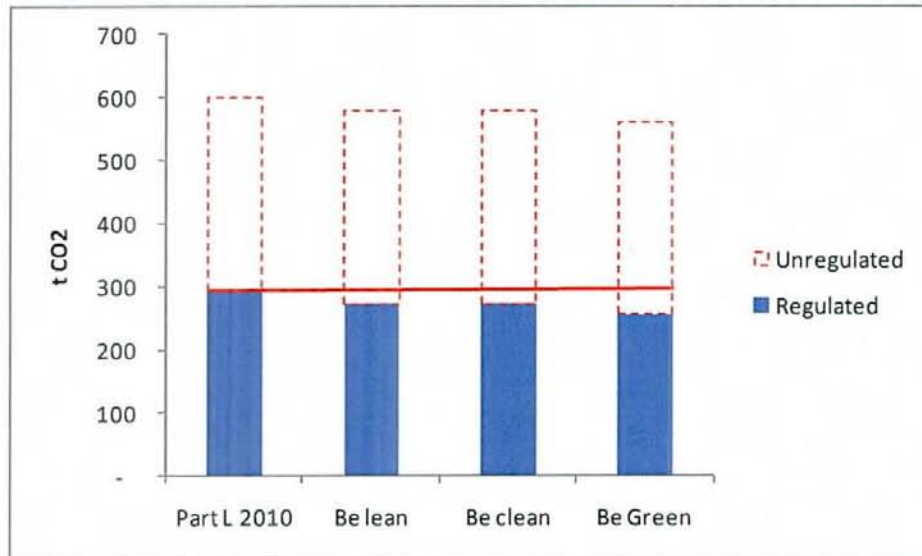
The following table highlights the improvement over the baseline Building Regulation compliant building with unregulated emissions. This shows a **14%** improvement against the regulated carbon emissions baseline and a **7%** improvement when unregulated emissions are included in the assessment.

■ **Table 13 Carbon Dioxide Emissions after each stage of the Energy Hierarchy**

	Carbon dioxide emissions (Tonnes CO ₂ per annum)			Improvement on Part L	Improvement on all emissions
	Regulated	Unregulated	Total	Percentage	Percentage
Building Regulations 2010 Part L Compliant Development	294	307	602	-	-
After energy demand reduction	274	307	581	7%	3%
After CHP	274	307	581	0%	0%
After renewable energy	255	307	562	6%	3%
Total Savings				14%	7%

The Figure below outlines the improvement on regulated and unregulated carbon emissions based on the Part L 2010 compliant building.

■ Figure 9 Improvement on Regulated and Unregulated Emissions



Appendix A Geology Assessment

This Appendix considers the geology and hydrogeology beneath the site. This is a preliminary assessment based on publicly available information and supported, where available, by site specific information from previous work undertaken at the site.

The geology of the site has been established from the geological map (BGS, 1999) along with information available from intrusive investigations at the site (SKM Enviros 2012).

Made ground is present across the site to an average depth of approximately 1.0m below ground level (bgl). In the east of the site the made ground is underlain by the Langley Silt Member while in the west of the site the made ground is indicated to be underlain by the Lynch Hill Gravel Member. Both these strata are anticipated to be approximately 5m in thickness. The drift deposits are indicated to be underlain by the London Clay Formation which is indicated from the cross section on the geological map to be approximately 50m in thickness.

The Langley Silt is anticipated to comprise sandy clay and silt while the Lynch Hill Gravel is anticipated to comprise sand and gravel. The London Clay comprises clay and silt with occasional sandy layers.

Published borehole logs for the site (BGS 2012) indicate that sands and gravels (likely to represent the Lynch Hill Gravel Member) are present to 5.4m bgl.

A borehole record exists for an exploratory hole advanced approximately 250m north of the site. The record indicates that the London Clay Formation is underlain by the Lambeth Group Formation (previously named the Woolwich and Reading Beds Formation) at a depth of approximately 47m bgl. This in turn is underlain by the Upper Chalk Formation at a depth of approximately 68m bgl.

The Lambeth Group Formation comprises interbedded clay, silt, sand and gravel.

An intrusive investigation was undertaken at the site in 2005. Ten exploratory holes were advanced to a maximum depth of 6m below ground level (bgl) (SKM Enviros 2012). Groundwater was recorded to have a rest level between 3.0m and 3.5m bgl in 2005. Further monitoring of existing standpipes was undertaken in 2011 and recorded groundwater was found to be between 3.6m and 3.7m bgl. Groundwater flow direction was assessed to be towards the west south west. This is towards the River Thames which is located approximately 10km from the site.

■ **Table 14 Hyde Park Hayes Geology**

Geological Unit	Thickness	Aquifer Status (EA 2012)	Composition
Made ground	Approximately 1m	Unclassified	Grey brown slightly clayey gravelly sand. Gravel comprises crushed concrete and brick.
Langley Silt Member (east of site only)	Approximately 5m	Unproductive Strata	Brown slightly sandy gravelly clay.
Lynch Hill Gravel Member (west of site only)	Approximately 5m	Principal Aquifer	Slightly clayey sandy gravel. Gravel comprises flint.
London Clay Formation	Approximately 50m	Unproductive Strata	Grey clay and silt, occasionally sandy
Lambeth Group Formation	Approximately 20m	Secondary A Aquifer	Clay, silt, sand and gravel
Upper Chalk Formation	Approximately 175m	Principal Aquifer	Chalk

Hydrogeology

The aquifer designation of the geological units has been assessed using information provided by the Environment Agency (EA 2012) and is summarised in Table 13 above. Both the Lynch Hill Gravel Member and the Upper Chalk Formation are classified as Principal Aquifers. The site is indicated not to lie within a groundwater source protection zone (EA 2012).

There is a groundwater abstraction from the Chalk aquifer approximately 140m north of the site (SKM Enviros 2012). The Water Framework Directive River Basin Management Plans for Groundwater in the area indicate the general groundwater chemical quality is 'Poor' and is predicted to continue to be 'Poor' in 2015 (EA 2012).

The Environment Agency's Catchment Abstraction Management Strategy (EA 2004) indicates that new non-consumptive groundwater abstractions will be allowed during winter (November to March inclusive) and summer (April to October inclusive). Consumptive groundwater abstractions, which are considered to have a direct and immediate impact on flows within the Thames, will not be permitted during summer months.

Previous investigation identified elevated concentrations of volatile organic compounds in groundwater within the gravels (SKM Enviros 2012). Additional chemical analysis of groundwater within the gravels in 2011 recorded concentrations of chromium, total petroleum hydrocarbons, vinyl chloride, dichloroethene and trichloroethene above drinking water standards. The majority of elevated concentrations were identified in BH6 and BH9 located on the upstream side of the site with respect to groundwater flow direction, suggesting a probable off-site source of contamination.

However, it was concluded that based on the distribution of exploratory holes available for monitoring an on-site historical source of contamination could not be completely eliminated.

Conclusions

Open Loop Groundwater Heating and Cooling System

Two aquifers are present beneath the site that would potentially support an open loop ground source heating and cooling system (GSHC). These are considered in turn below.

Lynch Hill Gravels: groundwater known to be present approximately 5m bgl with an anticipated flow direction towards the west south west. The gravels are only present in the western half of the site.

Risks: The potential sustainable abstraction rate from the gravel aquifer is not known. Potential for permeability of gravels to be limited by presence of clay, silt or fine sand. Gravels only present in west of site and consequently it may not be possible to achieve a sufficient spacing between the abstraction and discharge boreholes to avoid the risk of thermal breakthrough occurring. Absence of gravel strata in east of site may limit the amount of groundwater that can be abstracted from the upstream borehole. Environment Agency may not provide a licence for abstraction of groundwater from the gravels due to the potential for the abstraction of the water to influence the migration of elevated concentrations of contaminants known to be present in groundwater beneath the site. Abstraction of significant volumes of water from the gravels could potentially lead to localised settlement.

Chalk: depth to groundwater unknown but anticipated to be greater than 75m bgl. Aquifer likely to be present across whole of site footprint.

Risks: Groundwater flow direction not known, intrusive investigation likely to be required to determine this as part of feasibility study. Productivity of chalk can be variable due to fracture controlled groundwater flow. Design of abstraction and injection boreholes would have to eliminate the potential for the boreholes to create a pathway for contaminated water within the Lynch Hill Gravels to migrate downward to the Chalk aquifer. Increased liaison with the Environment Agency may also be required in relation to this issue. Cost of pumping will be greater than from the gravels. Risk of rapid water migration between discharge and abstraction boreholes if numerous fractures are present in the chalk.



Closed Loop Groundwater Heating and Cooling System

A closed loop GSHC could potentially be supported at the site either through the use of energy piles or dedicated closed loop boreholes. At this stage the assessment has not taken into consideration the potential ability of the thermal capacity of the ground to support such a system.

Risks: Design of closed loop boreholes would need to eliminate the potential for the boreholes to create a pathway for contaminated water within the Lynch Hill Gravels to migrate downward to the Chalk aquifer. Agreement from the Environment Agency may be required in relation to the type of carrier fluid used within the closed loop system.

BGS 1999: British Geological Survey, Geological Map of Windsor, Sheet 696, Solid and Drift Edition, 1999.

BGS 2012: British Geological Survey website. www.bgs.ac.uk/data/boreholescans/home/html consulted April 2012.

EA 2004: Thames Corridor Abstraction Management Strategy, Environment Agency, June 2004.

EA 2012: Environment Agency website. www.environment-agency.gov.uk consulted April 2012.

SKM Enviro 2012: Hyde Park, Hayes, Phase 1 Environmental Assessment HPH4.6. SKM Enviro on behalf of Melford Capital Partners, March 2012.