

Energy Statement

52-55 Friar St & 12 Greyfriars Road
Reading

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1.0 EXECUTIVE SUMMARY

This Energy Statement has been developed to detail the energy strategy for the proposed mixed-use redevelopment of the site at 52-55 Friar St & 12 Greyfriars Road, located in Reading. This statement relates to the final proposals, and is issued as part of the Full Planning Application for the development.

Energy and climate change planning policy in Reading currently follows the Reading's Core Strategy and the Sustainable Design and Construction Supplementary Planning Document, with 50% of the residential units to meet a carbon emissions reduction target of 19% over a Part L 2013 baseline for domestic development. This equates to an aggregated reduction in carbon emissions of 9.5% for the residential areas of the development. There is no minimum carbon emissions reduction target for non-residential areas, and as such the target for the retail units is minimum Part L 2013 compliance.

The proposed development will aspire to meet the intent of policy by delivering carbon dioxide emissions reductions over Part L 2013 (design intent), based on the approach, information, analysis and contents reported in this document.

The proposed development is currently predicting up to **26.7% in CO₂ emissions reduction over Part L 2013 for the domestic areas** of the development, and up to **19.7% CO₂ emissions reduction over Part L 2013 for the non-domestic** areas of the development. This equates to a total site-wide 25.7% CO₂ emissions reduction over Part L 2013 (based on the approach, information, analysis and contents reported in this document), through the following measures:

Domestic

- **BE LEAN (energy efficiency delivering up to a 3.4% improvement);**
- **BE CLEAN (CHP unit providing up to a further 23.3% savings);**
- **Total up to 26.7% savings.**

Non-domestic

- **BE LEAN (energy efficiency delivering up to a 17.4% improvement);**
- **BE GREEN (heat pump delivering up to 2.2% savings);**
- **Total up to 19.7% savings.**

The final size of CHP will be designed to suit the 'As-Designed' development at RIBA Stage 4. This follows the design process and enables the technologies to be optimised to achieve the required saving commitment.

The London Plan (2016) provides guidance for developments, which should follow an energy hierarchy when considering reducing CO₂ emissions. The London Plan has been used to inform this Energy Statement as an example of best practice for new developments within the UK. The energy hierarchy must consider incorporation of energy efficiency measures including passive design, supplying energy efficiently (with particular emphasis on decentralised energy generation including CHP) and using renewable energy technologies. The following summarises the key technical solutions that are proposed for the development:

Proposed Energy Efficiency Measures (Be Lean):

- Passive design principles (such as openable windows for the residential units) adopted in building massing and orientation;
- Glazing designed to reduce the cooling loads (where applicable);
- Air permeability improved beyond Part L notional values;
- Space heating and domestic hot water for all areas to be supplied from high efficiency communal gas fired boilers located in a central energy centre (as back-up to CHP);
- Boiler plant linked to BMS and includes central time control, weather compensation and metering;
- Cooling for commercial areas (note left as shell only) to be supplied from high efficiency VRF system;
- All buildings to be fitted with high efficiency lighting. Occupancy sensing and photoelectric daylight sensing in perimeter zones specified to commercial areas.

The final performance details and selection of the above Lean measures will be designed to suit the 'As-Designed' development at RIBA Stage 4. This follows the design process and enables the Lean design to be optimised to achieve the required saving commitment.

Decentralised Energy including CHP (Be Clean)

- From analysis undertaken on heat networks in the vicinity of the site, no existing or planned network was found. As such connection to an off-site decentralised energy network is not possible for the development.
- The development will have a significant heating and domestic hot water demand as a result of the residential component. Currently a predicted 25kW_e gas fired combined heat and power (CHP) plant, in conjunction with a thermal store of 6m³ located in a central plant room will act as lead boiler and supply LTHW to the whole development, meeting a significant proportion of the domestic hot water demand (DHW) and space heating requirements.

Renewable Energy (Be Green)

- A high efficiency VRF system has been assumed for the retail units, which will supply the units with a form of renewable heating.

The total site-wide CO₂ savings as predicted by this energy strategy is up to **38.5 tCO₂** when compared against the base-line scenario, which is a compliant Part L 2013 development (compliance with Criterion 1 and Criterion 3 achieved). The savings equate to an **overall 25.7% reduction** in regulated CO₂ emissions over the Part L 2013 baseline building emissions.

The following tables and graphs show the breakdown in CO₂ savings for the domestic and non-domestic areas for each stage of the energy hierarchy.

Domestic

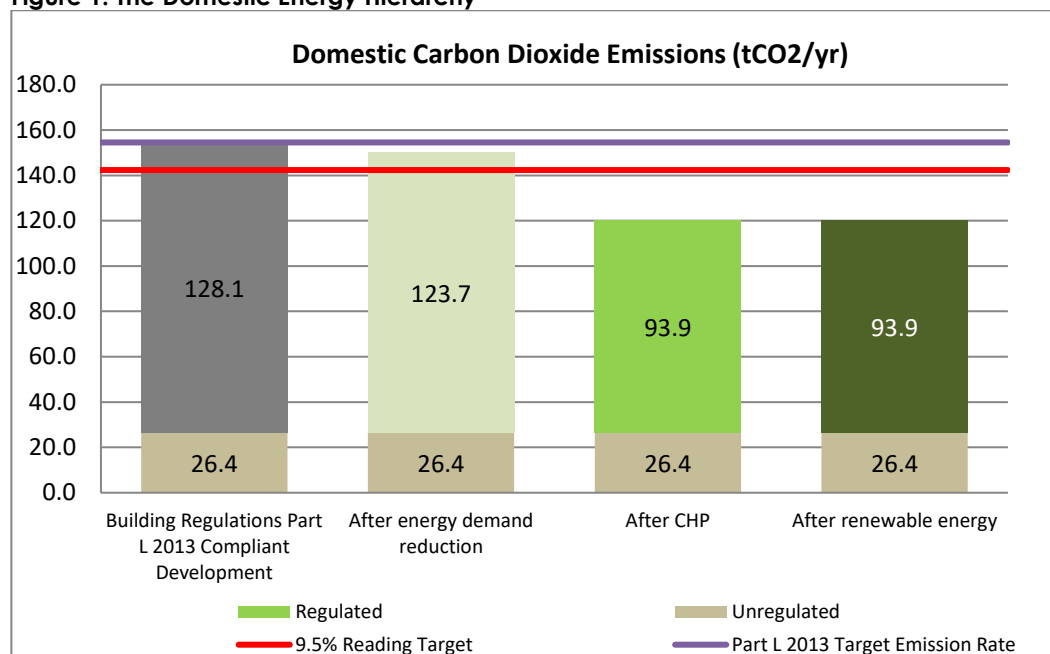
Table 1: Carbon dioxide emissions after each stage of the Energy Hierarchy for domestic

	Carbon dioxide emissions for domestic (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline: Part L 2013 of the Building Regulations Compliant Development	128.1	26.4	154.5
After energy demand reduction	123.7	26.4	150.1
After CHP	93.9	26.4	120.3
After renewable energy	93.9	26.4	120.3

Table 2: Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic

	Regulated domestic carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Savings from energy demand reduction	4.4	3.4%
Savings from CHP	29.8	23.3%
Savings from renewable energy	0.0	0.0%
Total cumulative on site savings	34.2	26.7%

Figure 1: The Domestic Energy Hierarchy

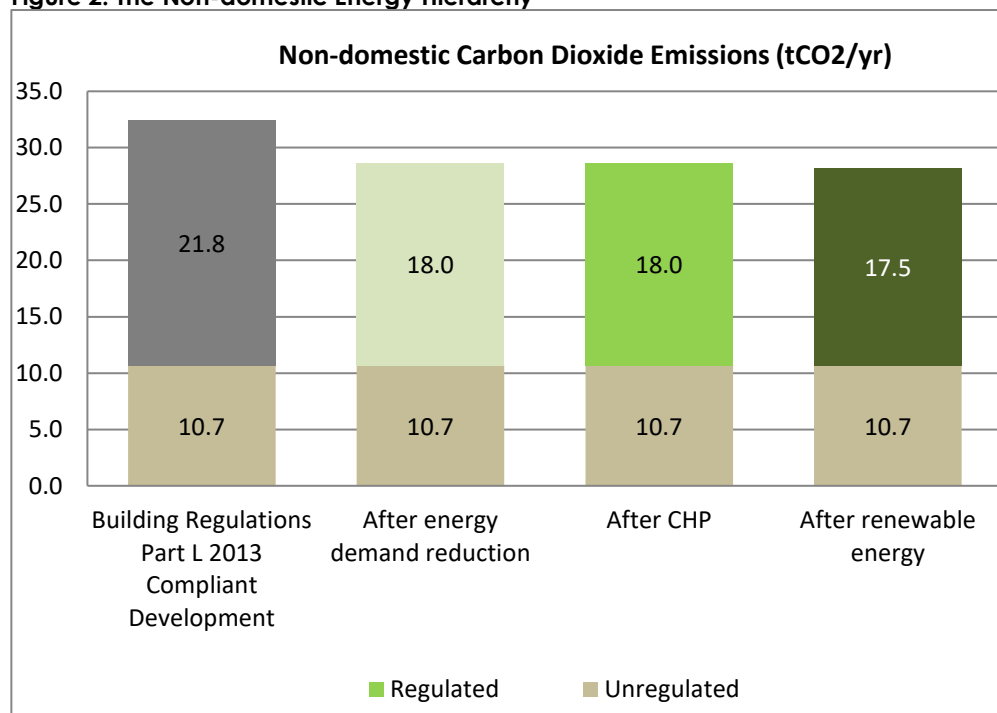


*Non-domestic***Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic**

	Carbon dioxide emissions for non-domestic (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline: Part L 2013 of the Building Regulations Compliant Development	21.8	10.7	32.5
After energy demand reduction	18.0	10.7	28.7
After CHP	18.0	10.7	28.7
After renewable energy	17.5	10.7	28.2

Table 4: Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Savings from energy demand reduction	3.8	17.4%
Savings from CHP	0	0%
Savings from renewable energy	0.5	2.2%
Total cumulative on-site savings (non-residential)	4.3	19.7%

Figure 2: The Non-domestic Energy Hierarchy

Site Total

Table 5: Site wide regulated carbon dioxide emissions and savings

	Total regulated emissions (Tonnes CO ₂ /year)	CO ₂ savings (Tonnes CO ₂ /year)	Percentage savings (%)
Part L baseline	149.9		
Be Lean	141.7	8.2	5.5%
Be Clean	111.9	29.8	19.9%
Be Green	111.4	0.5	0.33%
Total cumulative on site savings		38.5	25.7%

2.0 INTRODUCTION

This Energy Strategy for the proposed development at 52-55 Friar Street & 12 Greyfriars Road, located within Reading Borough, details the assessment process and the estimated CO₂ savings achieved through integration of passive design, energy efficiency measures and Low and Zero Carbon (LZC) technology. It also sets out how Reading's policies on energy and CO₂ emissions have been addressed.

The approach taken for the energy assessment is in line with the energy hierarchy as follows:

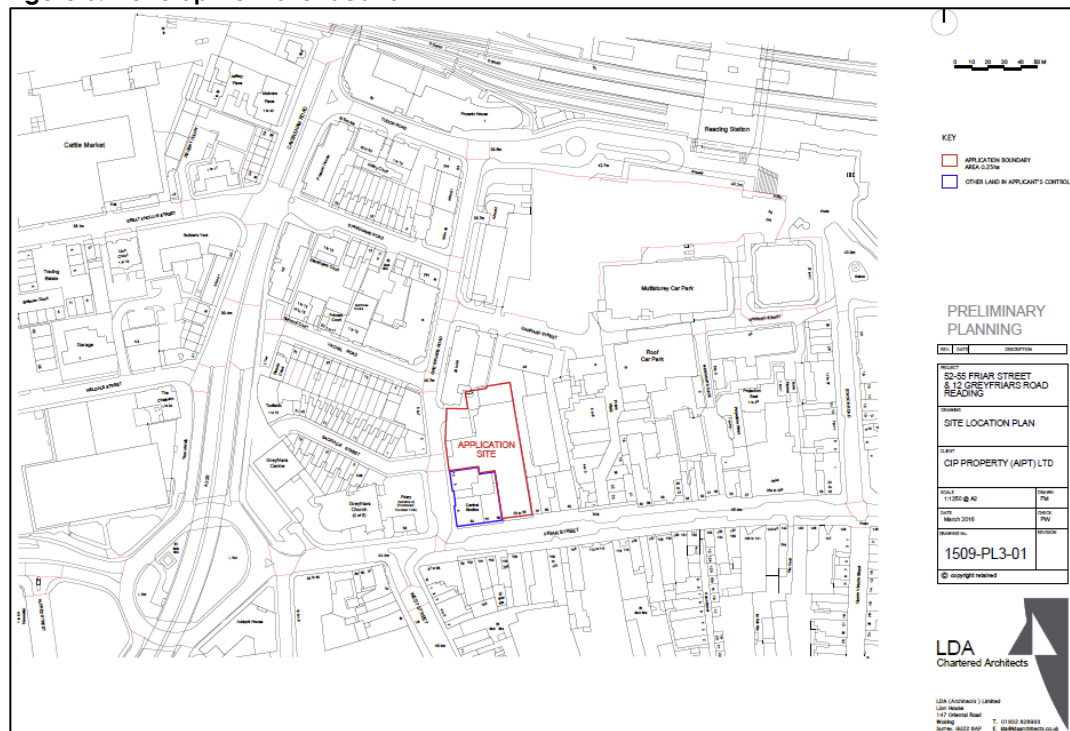
- Calculate baseline CO₂ emissions;
- Integrate measures to reduce energy demand and ensure efficient use of energy (Be Lean);
- Integrate CHP/CCHP (where appropriate) (Be Clean);
- Integrate renewable energy technology (Be Green);
- Calculate total CO₂ savings and final development CO₂ emissions.

2.1 Project Background

The Site comprises a four storey retail and office building dating to the mid 1970s. It is exceptionally bland and of no heritage value. The building is currently used by Sainsbury's supermarket. To the rear is copious storage and a hardstanding rear yard for supply deliveries. The Site has an irregular boundary and is approximately 85% developed.

The scheme proposals comprise three new medium rise buildings comprising new residential (private and affordable), office and retail uses. The built form would be lowest fronting Friar Street (8 storeys) stepping up as it progresses to the rear of the Site (northwards). Towards the rear the built form would be 12 storeys.

Figure 3: Development site location



The calculations in this Energy Statement are based on the drawings and area schedules issued by LDA architects on 28/10/16.

Table 6: Schedule of accommodation

Zone	Gross Internal Area (GIA) m ²
Residential	8,315
Retail	612
Car parking, cycle store, plant, refuse	1,828

The retail units are intended to be developed as shell only and are to be fitted out by future tenants/operators. The consideration of these areas within the energy assessment is detailed in the Methodology in Section 4.

3.0 PLANNING POLICY AND BUILDING REGULATION TARGETS

The development has been designed to meet sustainability and energy targets which are driven through:

1. UK Building Regulations Part L 2013;
 - a. Part L1A – New Dwellings
 - b. Part L2A – New Buildings Other than Dwellings
2. Reading Borough Council Core Strategy;
3. Reading Borough Council Sustainable Design and Construction SPD

3.1 Building Regulation Part L Summary

The development will comply with building regulation Part L 2013 (Conservation of fuel and power in buildings).

Part L1A (New Dwellings): applies to the new build residential areas of the development.

Part L2A (New Buildings other than Dwellings): applies to the new build retail areas of the development (i.e. all non-residential areas).

All areas of the development must be assessed against five criteria including Criterion 1 (Achieving the BER/DER) and Criterion 3 (Limiting the effects of solar gain in summer). Criterion 1 requires the CO₂ emissions of the new build development to be less than a target (the Target Emissions Rate or TER) and Criterion 3 requires that the building façade be designed to limit heat gain and reduce the requirement for air-conditioning. The residential areas are also required to achieve a dwelling fabric energy efficiency (DFEE) rate equal to or better than the target fabric energy efficiency (TFEE).

3.2 Reading Borough Council Core Strategy (Alteration Adopted 27th January 2015)

Policy CS1 of the Core Strategy require developments of greater than 10 dwellings and 1,000m² of non-residential floor space to achieve the following:

- Ensure that 50% of the provision meets the most up to date Eco-Homes and BREEAM 'Excellent' standards;
- All new developments maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand;
- Developments to incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development;

Reading's Sustainable Design and Construction SPD confirms that due to the changes in Building Regulations since the original issue of the Core Strategy the above carbon reductions (20% from energy efficient measures) are not referred to throughout the SPD. As such the planning policy requirements in relation to carbon emissions are:

- 50% of the dwellings to achieve a 19% reduction against Part L1A (equivalent to Code Level 4). This will be achieved through a site-wide reduction of c.10%.
- No minimum carbon emissions reduction for the retail units.

Appendix A6 of the SPD also sets out measures that can be implemented within the design to enhance the sustainability of development and reduce the carbon emissions. This energy statement will make reference to these technologies/features and will clarify the suitability of each item.

Other matters which relate to climate change mitigation and adaptation are set out in the following policies:

- CS2 – Waste Minimisation
- CS7 – Design and the Public Realm
- CS8 – Waterspaces
- CS23 – Sustainable Travel and Travel Plans
- CS24 – Car/ Cycle Parking
- CS34 – Pollution and Water Resources
- CS35 – Flooding
- CS36 – Biodiversity and Geology
- CS38 – Trees, Hedges and Woodlands

4.0 METHODOLOGY

4.1 Consideration of Shell Only Areas

The retail units are intended to be developed as shell only, to be fitted out by future tenants / operators. As such the scope of the current design and ability to influence energy efficiency in these areas is limited to the building fabric.

The recommended approach in such situations within Building Regulations Part L would be to assume worst case values for all unconfirmed building services (as per the minimum standards within the Non-Domestic Compliance Guide 2013).

However, given the performance gap between the Part L overall carbon targets and the minimum standards for building services, this approach would likely result in these areas failing to meet Part L Target Emission Rate (TER). Assumptions have been made for energy efficiency of lighting and building services installed by the Tenant based on good practice. As there is no reduction in carbon emissions required for the retail units the assumptions used within this statement have been set so as to achieve Part L compliance with a small margin, so as not to limit tenant's flexibility within their fit-out design.

4.2 Application of Energy Hierarchy

The project team has developed a holistic approach to energy and carbon performance. This approach is designed to reduce energy consumption and related CO₂ emissions in the first instance before considering how energy is to be supplied, as per the following methodology.

Use less energy

Step 1: form and façade – review the natural/energy resources at the site and consider adapting both the new and existing façades to respond to these studies.

Step 2: optimise criteria – optimise the design to reduce heating and cooling loads within the buildings.

Step 3: building fabric and passive design – develop passive heating and cooling design concepts for the buildings.

Step 4: energy efficient building services – develop an energy efficient building services strategy, through design and specification.

Step 5: operations – consider life-cycling issues, operational and maintenance factors.

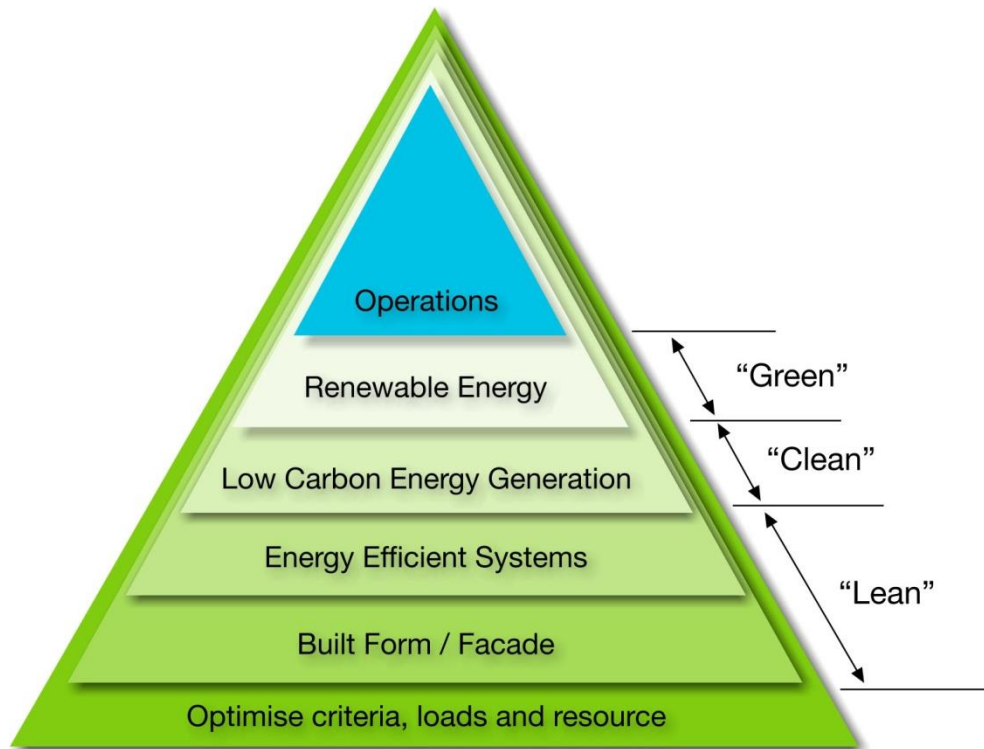
Use low carbon technology

Step 6: low-carbon energy generation – consider decentralised vs. Centralised plant including combined heat and power (CHP).

Use renewable energy

Step 7: renewable energy – analyse the suitability of the site for renewable energy generation and recommend appropriate technologies.

Figure 4: Energy Hierarchy



Each step in the Energy Hierarchy has been followed and carbon savings quantified separately for the 'Be Lean', 'Be Clean' and 'Be Green' scenarios within this statement.

5.0 BASELINE ENERGY CONSUMPTION AND CO₂ EMISSIONS

The strategy considers a Part L 2013 compliant baseline, which has been defined separately for the residential and commercial buildings on the site, as follows:

- New-build residential – Part L1A (2013) TER;**
 In order to determine energy and CO₂ figures for the residential building, a representative selection of residential units have been modelled using Stroma FSAP 2012 – according to the SAP 2012 methodology as per Building Regulations Part L1A 2013. This software calculates the Dwelling CO₂ Emissions Rate (DER) and Notional Target Emission Rate (TER). Emissions from unregulated energy consumption were estimated from SAP methodology.
- New-build commercial (non-residential) – Part L2A (2013) TER;**
 Commercial (non-residential) areas within the development have been modelled using Integrated Environmental Solutions (IES), Virtual Environment software 2014. This software creates a dynamic thermal model of the building, using ApacheSIM to calculate the building's loads, energy consumption and resulting CO₂ emissions. This software calculates the Building CO₂ Emissions Rate (BER) and Notional Target Emission Rate (TER) using the Building Regulations 2013 methodology based on the National Calculation Methodology (NCM).

5.1 Energy Models

IES calculates regulated energy consumption i.e. energy uses considered under Part L 2013, heating, cooling, domestic hot water (DHW), and electricity for lighting, pumps and fans. Unregulated energy consumption includes all energy not considered under Part L 2013, for example, gas for catering, small power, lifts and external lighting. An IES model was created for the retail units to dynamically simulate these areas and estimate the energy consumption and associated carbon emissions.

SAP software is used for calculating the energy consumption of residential buildings. SAP models were created for a selected number of typical residential floors, and were used to calculate the energy consumption for the building. The typical units / floors that were modelled are as follows:

Table 7: Residential Units Modelled in SAP

Block	Units Modelled
Block A	1.05, 2.05 & 3.05
Block B	5.01, 8.03, 8.06 & 9.06
Block C	1.01, 2.01 & 3.01

An estimation of energy consumption has been calculated using the results from IES and SAP to provide a total development carbon footprint.

5.2 Carbon emission factors

Carbon emission factors are based upon the Part L 2013 published figures:

Table 8: Carbon Emissions Factors

Gas	0.216	kgCO ₂ /kWh
Grid Supplied Electricity	0.519	kgCO ₂ /kWh
Grid Displaced Electricity	0.519	kgCO ₂ /kWh

5.3 Baseline Energy Consumption and CO₂ Emissions

The table below demonstrates the CO₂ emissions for the total development.

Table 9: CO₂ Emissions for the Baseline Scheme

BASELINE	Carbon dioxide emissions (tCO ₂ /yr)	
	Regulated	Unregulated
Domestic	128.1	26.4
Non-domestic	21.8	10.7
Total Baseline	149.9	37.0

The total site baseline CO₂ emissions are **149.9 tCO₂** (regulated energy uses).

6.0 IMPACT OF PASSIVE DESIGN AND ENERGY EFFICIENCY MEASURES (BE LEAN)

A key element of the energy strategy has been to maximise the energy efficiency of the buildings, through passive design and efficient servicing. The measures included within the design are described in detail below.

6.1 Form and Façade

The development has been analysed to determine the natural energy resources available on the site. The results from these studies have been used to inform the design in terms of massing of the new elements and design of the façades to harness the wind and solar benefits, maximising opportunities for using natural lighting, heating and cooling.

Effectiveness of the proposed measures has been tested against Part L Building Regulations Criterion 3 for both, residential and commercial areas. In both scenarios compliance is achieved. Results of compliance can be found in Appendix B and Appendix D.

6.2 Optimise Criteria

The design team has looked for opportunities within the design to reduce the heating and cooling loads within the building. Examples of where this has had an impact on the design include the following:

- Optimisation of the lighting strategy has meant that sizable heat loads are removed from the building, negating the requirement for excessive cooling;
- Passive solar design principles have been adopted to reduce heating and cooling loads;
- The glazing g-value specification has been optimized to control solar gain.
- Improving fabric performance will reduce the space heating loads in winter and cooling loads in summer.
- The development will be designed to be airtight with an air permeability target of 5m³/m²/hr at 50 Pa.

A summary of the proposed fabric and glazing specification for each area of the development is contained within the tables below:

Table 10: Target Fabric and Glazing Specifications

Domestic Fabric Targets:		
Element	Notional Building	Proposed Targets
External wall U-value	0.18 W/m ² K	0.15 W/m ² K
Roof U-value	0.13 W/m ² K	0.12 W/m ² K
Ground floor U-value	0.13 W/m ² K	0.11 W/m ² K
Doors U-value	1.0 W/m ² K	Heated corridors
Windows U-value* Windows g-value	1.6 W/m ² K 0.5	1.4 W/m ² K 0.6
Air permeability	5 m ³ /m ² /hr @ 50Pa	5 m ³ /m ² /hr @ 50Pa

Non-domestic Fabric Targets:		
Element	Notional Building	Proposed Targets
External wall U-value	0.26 W/m ² K	0.18 W/m ² K
Roof U-value	0.18 W/m ² K	0.18 W/m ² K
Ground floor U-value	0.22 W/m ² K	0.18 W/m ² K
Doors U-value	2.2 W/m ² K	2.0 W/m ² K
Windows U-value* Windows g-value	1.6 W/m ² K 0.5	1.4 W/m ² K 0.4
Air permeability	3 m ³ /m ² /hr @ 50Pa	5 m ³ /m ² /hr @ 50Pa

* Overall Window = Glass + Frame + Losses

6.3 Energy Efficient Building Services

The following energy efficiency measures within the building services are proposed for the development:

- Effective control of electric lighting is a key factor in maximising the potential energy savings when adequate daylight is present. Daylight sensors are to be specified to the retail spaces, which used in combination with occupancy sensors and efficient luminaires to ensure low power density will significantly reduce the energy consumption from lighting;
- Efficient display lighting to be specified with luminous efficacy of 25 lm/W (or higher) with time switch;
- High efficiency communal boilers will be installed to provide heat in conjunction with the proposed Combined Heat and Power (CHP) unit for the residential areas;

- The majority of the residential units will be ventilated via natural ventilation, where units fronting Friar St and Greyfriars Road up to the 3rd floor will have mechanical ventilation with heat recovery due to localised air pollution issues;
- Enhanced pipework and ductwork thermal insulation;
- Measures to reduce water consumption within the buildings will have an impact on the energy consumption. A reduction in water consumption should result in reduced energy demand due to the reduction in electricity required to pump water, and reduction in energy for heating the domestic hot water (DHW) supply.

Whilst these are the design standards currently targeted, their achievability will be reviewed through detailed design stages to ensure the overall CO₂ reduction targets are maintained, and to take into account any design changes.

As the retail units will be developed to a Shell only standard the system inputs used within the energy models have been assumed as good practice for tenant fit-outs.

Details of the energy efficiency inputs for residential and commercial areas can be found in Appendix A and Appendix C respectively.

6.4 'Be Lean' Energy Consumption and CO₂ Emissions

The IES and SAP models have been run to calculate the resulting energy consumption and CO₂ emissions taking into account the passive design and energy efficiency measures detailed within the previous section.

Referring back to the baseline scheme, the resulting CO₂ savings for the energy efficient scheme are detailed in the table below:

Table 11: CO₂ savings for the energy efficient scheme

'Be Lean'	Carbon dioxide emissions (tCO ₂ /yr)		
	Regulated	Unregulated	Total
<i>Domestic</i>			
Emissions after demand reduction (tCO ₂ /yr)	128.1	26.4	154.5
Savings (tCO ₂ /yr)	4.4	0.0	4.4
Savings (%)	3.4%	0.0%	2.8%
<i>Non-domestic</i>			
Emissions after demand reduction (tCO ₂ /yr)	18.0	10.7	28.7
Savings (tCO ₂ /yr)	3.8	0.0	3.8
Savings (%)	17.4%	0.0%	11.7%
<i>Site Total</i>			
Emissions after demand reduction (tCO ₂ /yr)	141.7	37.0	178.6
Savings (tCO ₂ /yr)	8.2	0.0	8.2
Savings (%)	5.5%	0.0%	4.4%

The total CO₂ savings achieved through integration of high efficiency building fabric and building services is **8.2 tCO₂**. This is equivalent to a **4.4% reduction for the domestic areas** and a **17.4% reduction for the non-domestic areas**, and a 5.5% reduction overall for the site.

Table 12: Lean scenario Part L performance

'Be Lean'	Passes Part L?	% improvement on Part L 2013
Domestic	Yes	3.4%
Non-domestic	Yes	17.4%
Development Aggregate	-	5.5%

This demonstrates that all areas exceed Building Regulations Part L requirements through demand reduction measures alone.

The development aggregate achieves a 5.5% reduction over Part L 2013 TER CO₂ emissions (The "Lean" stage percentage savings on the baseline).

7.0 ASSESSMENT OF LOW CARBON TECHNOLOGIES (BE CLEAN)

The second stage of the 'Be Lean', 'Be Clean', and 'Be Green' methodology concerns low-carbon energy generation ('clean' solutions) and considers decentralised energy generation, including combined heat and power (CHP).

The following opportunities have been assessed within the development:

- Connection to existing heat networks beyond the site boundary;
- Connection to existing low carbon heat distribution networks including combined heat and power (CHP);
- Providing a site-wide heating network including combined heat and power (CHP);
- Providing a low carbon cooling strategy including combined cooling heat and power (CCHP).

7.1 Connection to District Heat Network

From analysis undertaken on heat networks in the vicinity of the site, no existing or planned network was found. As such connection to an off-site decentralised energy network is not possible for the development.

7.2 Combined Heat and Power (CHP)

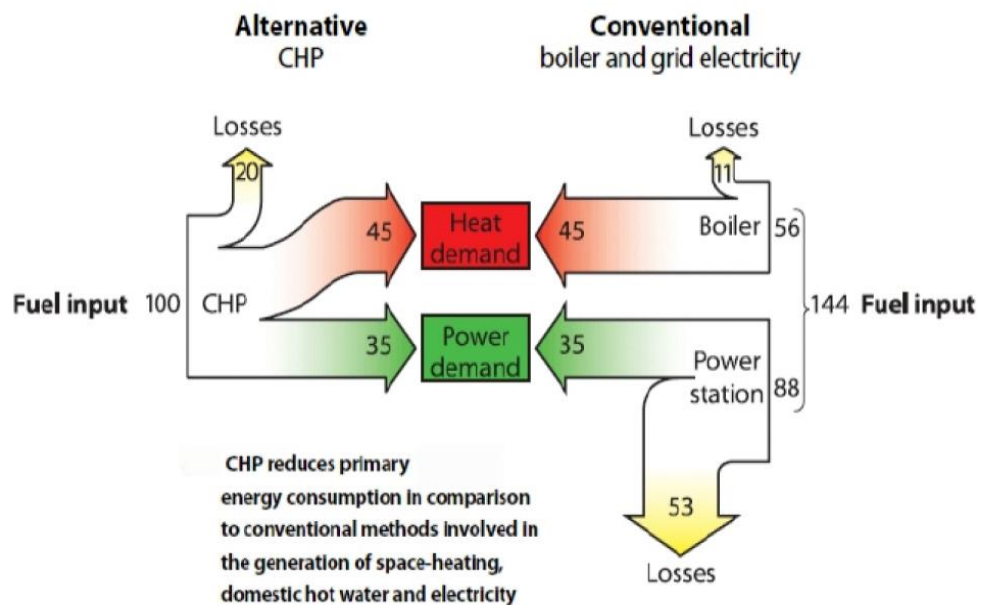
CHP converts a single fuel into both electricity and heat in a single process at the point of use. Communal CHP is particularly suitable for applications where there is a constant demand for both heat and electricity throughout the year; such is the case at the proposed development at 52-55 Friar St due to the hot water demand from the residential units.

As no current opportunities can be confirmed for connection to existing district heat networks, the proposed strategy incorporates decentralised energy generation from an on-site CHP engine. Gas fired combined heat and power plant located in a central plant room will act as lead boiler and supply LTHW to the whole development. In order to optimize the running hours of the CHP at full capacity, the system will be sized on the base load and will be providing the Domestic Hot Water (DHW) and Space Heating for the development.

Communal heating has several advantages compared to individual heating:

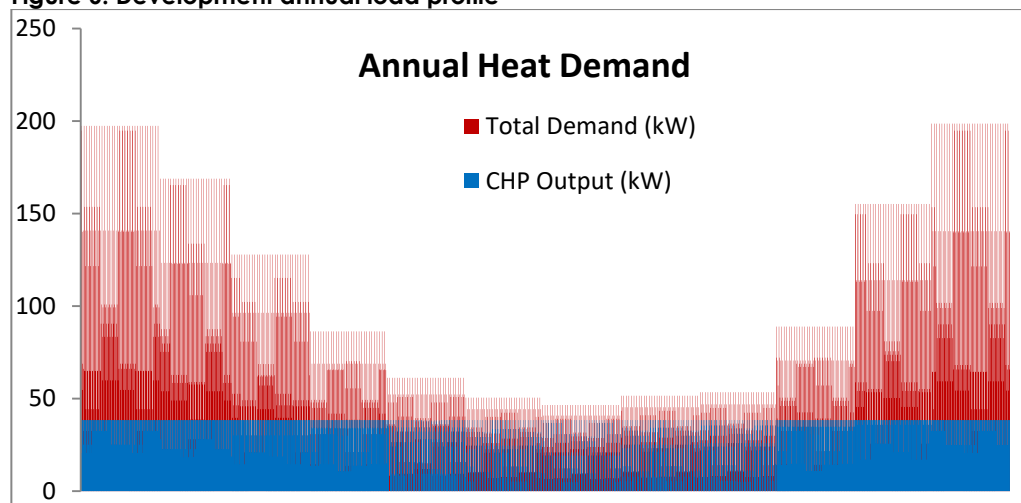
- The central plant rooms can be centrally and efficiently maintained by the building's facilities management team;
- Improved economies of scale with the use of larger heating plant and systems, and centralised plant provides additional storage space within other areas of the building;
- It is estimated that the running costs of the communal heating scheme will be lower than for a conventional system; and
- Having a single heating plant set will bring flexibility in the future in terms of heat energy source options and will allow an increased opportunity for potential integration of low and zero carbon (LZC) energy systems.

Figure 5: Comparison of heat supply, power supply and losses for CHP and conventional sources



When sizing CHP plant, it is fundamental to ensure that 100% of its outputs (both electrical and thermal) are going to be used. Analysis has been carried out by the design team to determine the thermal and electrical load profiles using the outputs from the SAP models.

Figure 6: Development annual load profile



The size of the CHP will be optimised based on the base thermal load profile before renewable systems have been considered for the site.

Figure 7: Development typical winter daily load profile

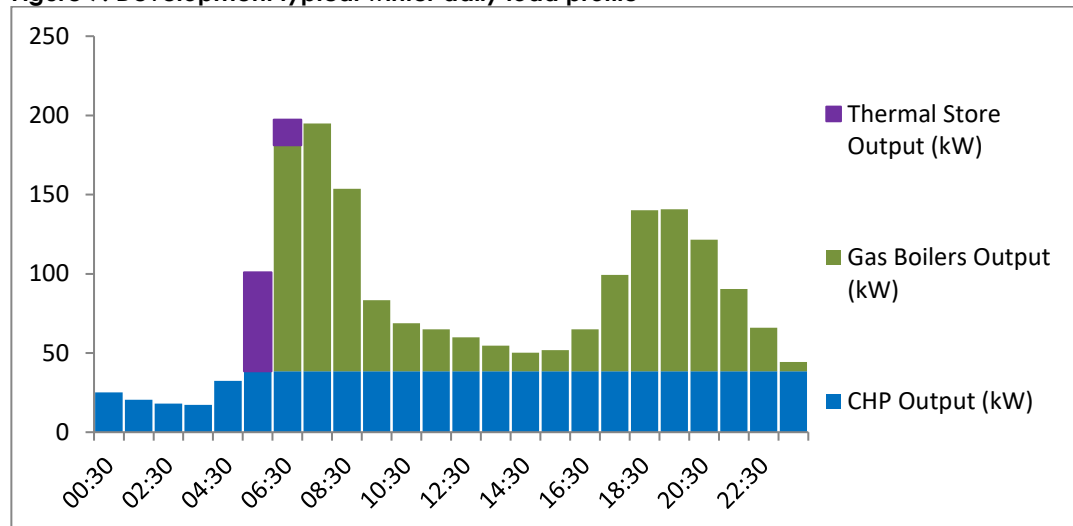
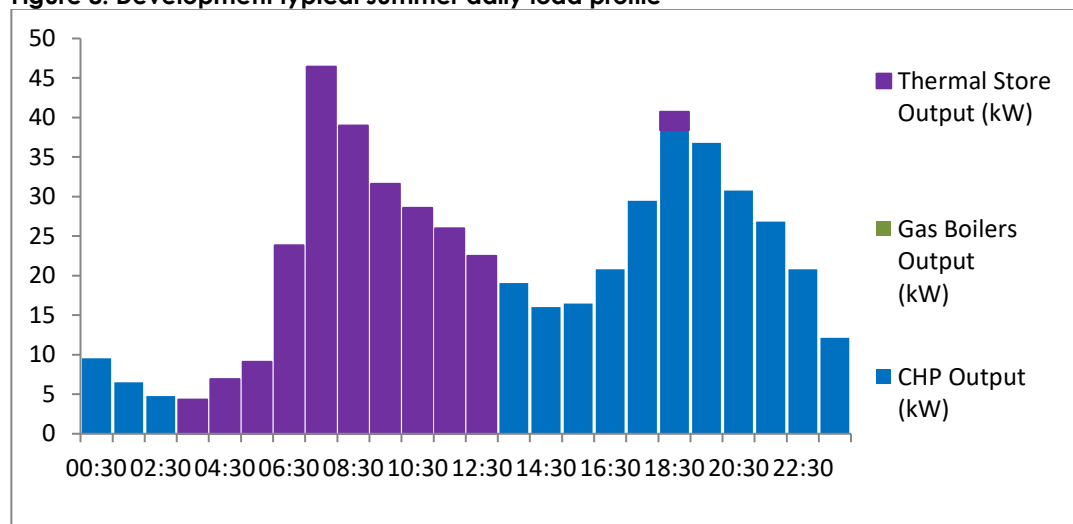


Figure 8: Development typical summer daily load profile



The predicted Load analysis suggests that the development has a sufficient thermal base-load to install a single communal gas fired CHP engine rated up to 25 kW_e, 38.4kW_{th}, in conjunction with a thermal store of up to 6m³. A range of CHP engines and thermal store sizes have been evaluated in order to optimise CO₂ savings; however, it has been found that sizes above 25 kW_e will not meet the criteria for effective CHP installations of annual running hours >5000. Following the load predictions and CHP size variations study an Ener-G E25 CHP engine has been assumed in calculations for this energy strategy – please see Appendix E.

The unit is intended to meet the majority of the DHW and heating demand in the residential areas. The thermal store will act to increase the running hours of the engine and reduce the number of start times whilst enabling a degree of the space heating to be produced via the CHP as well.

It has also been determined that there is likely to be sufficient electrical base-load on site to ensure the electricity generated from the CHP unit will be used within the development. Should the electrical base load be exceeded, electricity could be fed into the National Grid.

As there is sufficient base load within the development and restrictions on plant area, it is not anticipated that any heat will be sold to users off-site. Heat delivered to tenants on-site will be supplied and metered via Heat Interface Units (HIUs).

The predicted operating hours and load profiles of each building have been sourced from Part L National Calculation Methodology (NCM) templates and industry standards, however, in practice, the actual number of operating hours should be optimised by the operator and the figures shown here are considered for the purpose of the energy strategy assessment at the planning stage.

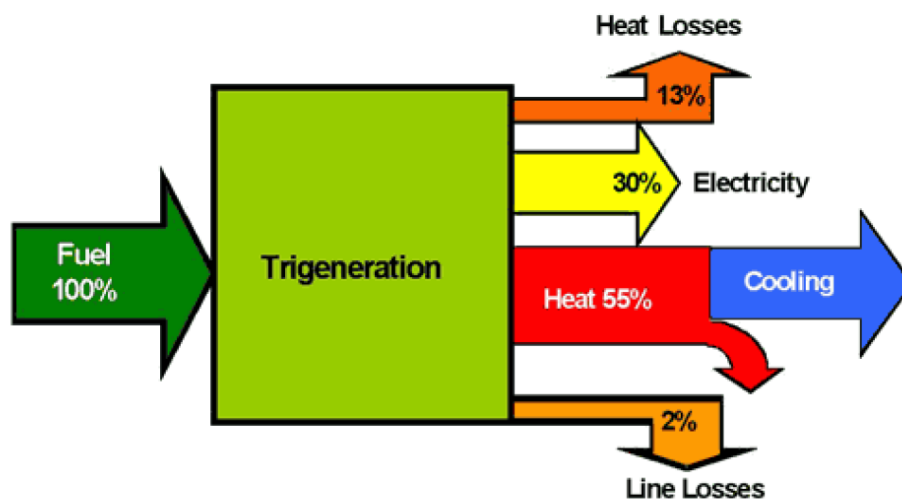
The assumed CHP engine output will serve only the residential areas, with the retail areas having their own standalone system following their tenant fit-out. From the CHP analysis performed up to 63% of the total DHW and space heating demand is predicted to be supplied by the CHP, and the CHP engine is anticipated to run for approx. 7,400 hours throughout the year.

NB: Good quality CHP is eligible for fiscal incentives of good quality CHP including exemption from the climate change levy for all fuel inputs and electrical outputs and eligibility for enhanced capital allowances for the plant. Good quality CHP is defined as measured by the CHP quality assurance program (CHPQA). The unit assumed in this report complies with the above criteria – please see Appendix F.

7.3 Combined Cooling Heat and Power (CCHP)

CCHP is an extension of a standard CHP scheme with part or all of the heat produced from the CHP engine used to supply input energy to an absorption chiller.

Figure 9: Heat supply, power supply, cooling supply and losses for CCHP system



As cooling is not proposed for the residential areas, and the retail units will be developed to a Shell only standard, CCHP is not suitable for this development.

7.4 'Be Clean' Energy Consumption and CO₂ Emissions

The total CO₂ savings achieved through integration of a communal gas-fired CHP system is **21.8 tCO₂**. This is equivalent to an **17.6% reduction for the domestic areas** and a **0% reduction for the non-domestic areas**, and a 14.9% reduction overall for the site.

Table 13: Carbon emissions savings as a result of gas fired CHP

'Be Clean'	Carbon dioxide emissions (tCO ₂ /yr)		
	Regulated	Unregulated	Total
<i>Domestic</i>			
Emissions after demand reduction and CHP (tCO ₂ /yr)	93.9	26.4	120.3
Savings from CHP (tCO ₂ /yr)	29.8	0.0	29.8
Savings (%)	23.3%	0.0%	19.8%
<i>Non-domestic</i>			
Emissions after demand reduction and CHP (tCO ₂ /yr)	18.0	10.7	28.7
Savings from CHP (tCO ₂ /yr)	0	0.0	0
Savings (%)	0%	0.0%	0%
<i>Site Total</i>			
Emissions after demand reduction and CHP (tCO ₂ /yr)	111.9	37.0	148.8
Savings from CHP (tCO ₂ /yr)	29.8	0.0	29.8
Savings (%)	19.9%	0.0%	16.7%

8.0 ASSESSMENT OF RENEWABLE TECHNOLOGIES (BE GREEN)

A feasibility study has been carried out to establish the most appropriate local LZC energy source for the building. The study has assessed the natural resources available on site, and analysed the feasibility of each LZC energy source against the building's energy demands.

The following LZC technologies are identified within both Reading's Sustainable Design and Construction SPD (Appendix 6 of the SPD) and BREEAM credit guidance. These technologies have been considered for use at 52-55 Friar St.

Table 14: Renewable and low carbon technologies considered for the development

Solar	• Solar thermal • Solar photovoltaics
Wind	• Wind turbines
Biomass	• Biomass single room heaters/stoves • Biomass boilers • Biomass community heating schemes
Combined heat and power (CHP)	• Biomass • Natural gas • Sewerage gas and other biogases
Heat Pumps	• Ground source heat pumps • Water source heat pumps • Air source heat pumps • Geothermal heating systems
Fuel Cells	• Fuel cells using hydrogen generated from any of the above 'renewable' sources.

8.1 Feasibility of Renewable Technologies

An initial assessment has been carried out to determine which technologies are technically feasible on the site. For technologies which are identified as feasible, the following factors have been considered to determine which technologies are appropriate in terms of economic and local planning feasibility:

- Energy generated from each LZC energy source per year
- Payback
- Land Use
- Local Planning Criteria
- Noise
- Life cycle cost/lifecycle impact of the potential specification in terms of carbon emissions
- Any available grants

All technologies appropriate to the site and energy demand of the development have been assessed. Where technologies are not considered appropriate, justification for their exclusion has been provided.

8.2 Solar Panels (Solar Thermal and Photovoltaic PV)

The table below summarises the desktop study undertaken to determine the feasibility of solar thermal or photovoltaic panels at the site:

Table 15: Key considerations of solar technology

Technology	Criteria	Requirement Met?
Solar Thermal		
Roof orientation	Are available roofs facing south-west to south-east (through south), or flat?	✓
Roof space	Is there sufficient un-shaded roof area?	✓
Hot water demand	Is there year round hot water demand?	✓
Heating system	Would a solar thermal collector be compatible with the proposed heating system?	✓
Hot water storage	Is there space for a hot water storage vessel?	✓
Conflicts with other systems?	Will solar thermal conflict with other systems (e.g. CHP) which are higher up the energy hierarchy?	✗
PV		
Roof orientation	Are available roofs facing south-west to south-east (through south), or flat?	✓
Roof space	Is there sufficient un-shaded roof area?	✓
Electrical demand	Is there adequate electrical demand on site?	✗

Solar thermal panels are not considered appropriate for the site as the thermal output would conflict with the output from a CHP unit as both are sized to provide either all or part of the development's base thermal load. Preference has been given to a CHP unit as this can provide a greater carbon reduction for the whole development at a lower cost.

Typical PV installations for residential developments feed the landlord supply from the electricity generated from the array. However as the commercial units will not receive any infrastructure for services (i.e. shell only) the electricity produced in this case would then need to be split to serve the individual residential units. This poses difficulties in terms of capital costs and maintenance of the PV panels and associated controls and equipment.

The development's location relative to its neighbours also poses an issue with respect to views from other developments. As the 3No. blocks of the development at 52-55 Friar St are overlooked by a neighbouring development (the Stanhope development to the east which has received outline planning from Reading Borough Council) PV panels were not deemed suitable for any of the roofs.

Due to the above constraints and as the proposed CHP engine will provide low carbon electricity to the development, PV panels are not proposed for inclusion for the development at 52-55 Friar St.

8.3 Wind Turbines

The table below summarises the desktop study undertaken to determine the feasibility of either roof mounted or standalone wind turbines at the site:

Table 16: Key considerations of wind technology

Technology	Criteria	Requirement Met?
Stand-alone Wind Turbine		
Wind speed	Is average wind speed greater than 6m/s at hub height?	✓
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	✗
Open land around proposed site	Is there sufficient open land for a turbine to be installed?	✗
Distance to nearest property	Are surrounding properties far away enough to avoid noise disturbance?	✗

Therefore, wind technology is not recommended for this development.

8.4 Biofuel Community Heating Scheme

The table below summarises the desktop study undertaken to determine the feasibility of a biofuel heating scheme at the site:

Table 17: Key considerations of biofuel technology

Technology	Criteria	Requirement Met?
Woody Biomass		
Heat demand	Is there a year round heat demand?	✓
Supply chain	Is there an established supply chain in the local area?	✓
Delivery logistics	Is the site accessible for deliveries? Is there sufficient space for a supply vehicle to access a biomass storage tank?	✗
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	✗
Plant room	Is there sufficient space for a biofuel boiler and associated auxiliary equipment?	✓
Flue	Can the flue be designed to meet planning authority requirements?	✓
Liquid Biofuel		
Heat demand	Is there a year round heat demand?	✓
Supply chain	Is there an established supply chain in the local area? And can the required quantities of biofuel be guaranteed?	✓
Security of supply	Is the future supply of biofuel guaranteed?	?
Delivery logistics	Is the site accessible for deliveries? Is there sufficient space for a supply vehicle to access a biofuel storage tank?	✓
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	✓
Running costs	Are the high running costs acceptable?	✗

Wood chips / pellets would require a large number of deliveries and storage, not compatible with a city centre location. Liquid biofuel requires less storage space, and has been considered in further detail by the design team.

The biodiesel is typically tested against EN14214, and supplied as pure Biodiesel at B100. Certain suppliers have plans to supply liquid biodiesel to sites around London via tanker. The tanker is anticipated to be sized to hold between 3,000 and 5,000 litres per delivery. Once delivered, the fuel would be pumped to a holding tank onsite, so the location of this tank would need to be accommodated.

Suppliers link their prices to crude oil and kerosene, reviewing prices monthly against the Rotterdam Exchange which considers waste oil prices. As waste oil is now traded as a commodity, prices are high and subject to fluctuation.

Suppliers sell biodiesel as both road transport fuel and heating oil. When sold as a road transport fuel, the supply company can claim 25p/litre back through the Renewable Fuel Certificates (RFC's). This subsidy is not available for biodiesel heating fuel so, to compensate, this additional cost is added into the fuel price and passed onto the client.

Typical prices of Biodiesel are based upon the supplier's fixed processing costs (15p) + RFC (25p) + price of waste cooking oil (variable, but potentially 45p – 60p). This means that the overall fuel cost is likely to be in the region of 85p – £1.00 per litre, compared to gas which is currently in the region of 30-50p per litre. Discussions with various suppliers determined that there is a lot of uncertainty regarding pricing in the market and this fuel price is likely to fluctuate over the next few years.

Liquid Biofuel, including FAME, are not currently included as recognised fuels within the Renewable Heat Incentive (RHI) Scheme, so unlike other renewable heating fuels, additional funding is not available.

Due to uncertainties in the market, regarding pricing and supply, as well as the demand from the transport industry, liquid biofuel is not recommended for the development at 52-55 Friar St.

8.5 Biofuel Combined Heat and Power (CHP)

The table below summarises the previous discussions regarding the feasibility of gas-fired and biofuel heating schemes at the site:

Table 18: Key considerations of combined heat and power (CHP) technology

Technology	Criteria	Requirement Met?
Gas-fired		
Feasible	Is gas-fired CHP to be implemented	✓
Biomass		
Feasible	Is a biomass heating source recommended?	✗
Biofuel		
Feasible	Is a biofuel heating source recommended?	✗

A gas-fired CHP system has been analysed within Section 7.3 and is recommended for the site.

A biomass/biofuel system is not recommended due to the reasons explained in the section above.

8.6 Heat Pumps (Ground/Water/Air/Geothermal)

The table below summarises the desktop study undertaken to determine the feasibility of ground source, air source or water source heat pumps at the site (there is no geo-thermal resource available):

Table 19: Key considerations of heat pump technology

Technology	Criteria	Requirement Met?
Heat distribution system	Is it possible to have a low-grade distribution system e.g. under floor heating?	✓
Heat distribution system	Is it compatible with the proposed cooling system?	✓
Ground-source Heat Pump		
Ground conditions	Has a basic ground study concluded that the site is suitable for GSHP?	✗
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	✗
Vertical piping	Is the ground suitable for vertical piping? Can underground obstacles be avoided?	tbc
Plant room	Is there space allowed for a GSHP and associated auxiliary equipment?	✓
Water-source Heat Pump		
Resource	Is there an available water source close to the site?	✗
Access	Can the available water source be accessed?	✗
Air Source Heat Pump		
Roof space	Is there sufficient available roof space for air-source heat pumps for the development?	✓

Due to the limited space available at the site, a horizontal loop system could not be installed. Similarly, as the site footprint is relatively small compared to the total area, it is unlikely that a significant yield could be achieved via boreholes or thermopiles in the ground.

As the retail units will not be provided capped connection to the communal system, it is likely incoming tenants will install a VRF system to provide heating and cooling, together with their own ventilation plant. As such heat pumps are assumed as a 'Be Green' measure for the retail units. Only savings from heating have been reported (i.e. the SEER is the same for the Lean, Clean and Green steps).

8.7 Fuel Cells

The table below summarises the desktop study undertaken to determine the feasibility of fuel cell technology at the site:

Table 20: Key considerations of fuel cell technology

Technology	Criteria	Requirement Met?
Fuel Cells		
Fuel Supply	Is there a source of hydrogen available?	✗
Fuel Supply	Is there an alternate fuel source available?	✓
Plant room	Is there space allowed for a fuel cell and associated auxiliary equipment?	✓

The primary fuel source for fuel cells is hydrogen. This can be obtained (using a reformer) from a wide range of fuel supplies including natural gas, coal gas, methanol, landfill gas and other fuels containing hydrogen.

Fuel cells produce zero emissions (at the point of use) when running on pure hydrogen. However most building applications to date have involved the use of carbon based fuels (primarily natural gas) requiring the use of a reformer. A consequence of the reforming process is the emission of carbon dioxide, although emissions are still lower than conventional combustion processes due to the higher operating efficiency of the fuel cell.

The efficiencies of fuel-cell plants are in the range of 40 to 55% (electrical power generation) and waste heat is generated making it a co-generation energy source.

There is not currently a hydrogen network in proximity to the site, although there is a very good natural gas infrastructure hence the majority of fuel cells are operating using natural gas. Analysis has shown that the carbon savings realised from gas fired CHP outweigh those from a hydrogen fuel cell that is powered by natural gas due to the conversion process from gas to hydrogen.

The lower efficiencies when compared to a gas-fired CHP unit coupled with the higher capital costs mean that fuel cell technology is not considered appropriate at this time for the development at 52-55 Friar St.

8.8 'Be Green' Energy Consumption and CO₂ Emissions

Table 21: Carbon emissions savings as a result of gas fired CHP

'Be Clean'	Carbon dioxide emissions (tCO ₂ /yr)		
	Regulated	Unregulated	Total
<i>Domestic</i>			
Emissions after renewable energy (tCO ₂ /yr)	93.9	26.4	120.3
Savings from renewable energy (tCO ₂ /yr)	0	0.0	0
Savings (%)	0%	0.0%	0%
<i>Non-domestic</i>			
Emissions after renewable energy (tCO ₂ /yr)	17.5	10.7	28.2
Savings from renewable energy (tCO ₂ /yr)	0.5	0.0	0.5
Savings (%)	2.2%	0.0%	1.7%
<i>Site Total</i>			
Emissions after renewable energy (tCO ₂ /yr)	111.4	37.0	148.4
Savings from renewable energy (tCO ₂ /yr)	0.5	0.0	0.5
Savings (%)	0.33%	0.0%	0.33%

9.0 CONCLUSION

The total CO₂ savings achieved by the development's energy strategy is **33.9 tCO₂** when compared against the base-line scenario, which is a compliant Part L 2013 development (compliance with Criterion 1 and Criterion 3 achieved). The savings equate to an **overall 23.2% reduction** in regulated scheme CO₂ emissions over the Part L 2013 baseline building emissions.

The following sections show the breakdown in CO₂ savings for the domestic and non-domestic areas for each stage of the energy hierarchy.

9.1 Domestic CO₂ Emissions Savings

The domestic areas of the development have been designed to show a total CO₂ savings of **34.2 tCO₂** which equates to a **26.7% reduction** over Part L 2013. The following tables and graph show a breakdown of the results.

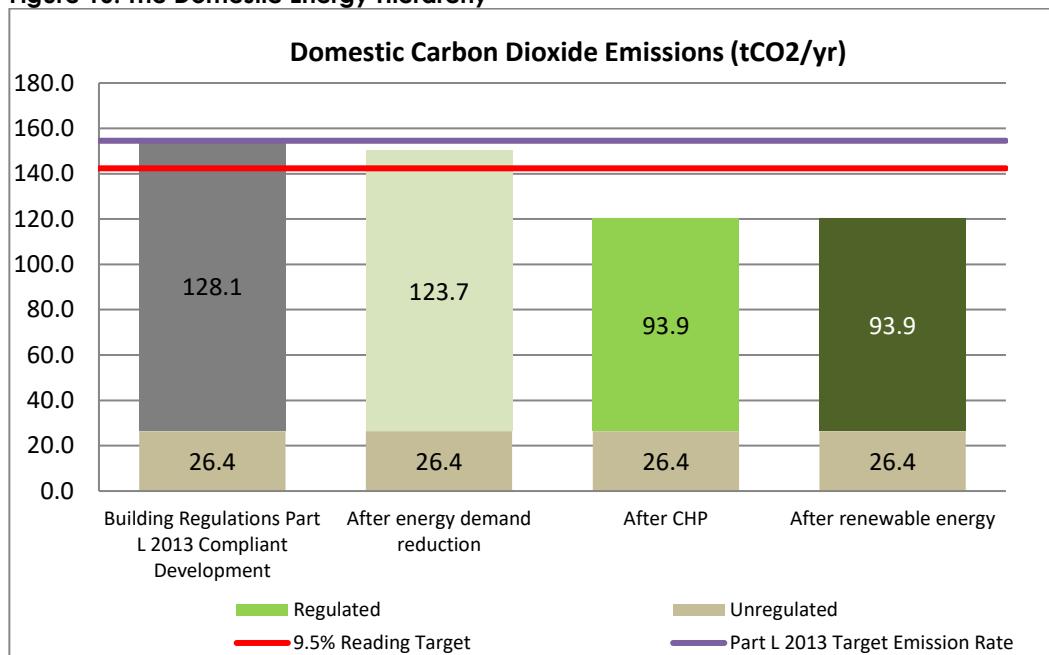
Table 22: Carbon dioxide emissions after each stage of the Energy Hierarchy for domestic

	Carbon dioxide emissions for domestic (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline: Part L 2013 of the Building Regulations Compliant Development	128.1	26.4	154.5
After energy demand reduction	123.7	26.4	150.1
After CHP	93.9	26.4	120.3
After renewable energy	93.9	26.4	120.3

Table 23: Regulated carbon dioxide savings from each stage of the Energy Hierarchy for domestic

	Regulated domestic carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Savings from energy demand reduction	4.4	3.4%
Savings from CHP	29.8	23.3%
Savings from renewable energy	0.0	0.0%
Total cumulative on site savings	34.2	26.7%

Figure 10: The Domestic Energy Hierarchy



9.2

Non-domestic CO₂ Emissions Savings

The non-domestic areas of the development have been designed to show a total CO₂ savings of **4.3 tCO₂** which equates to a **19.7% reduction** over Part L 2013. The following tables and graph show a breakdown of the results.

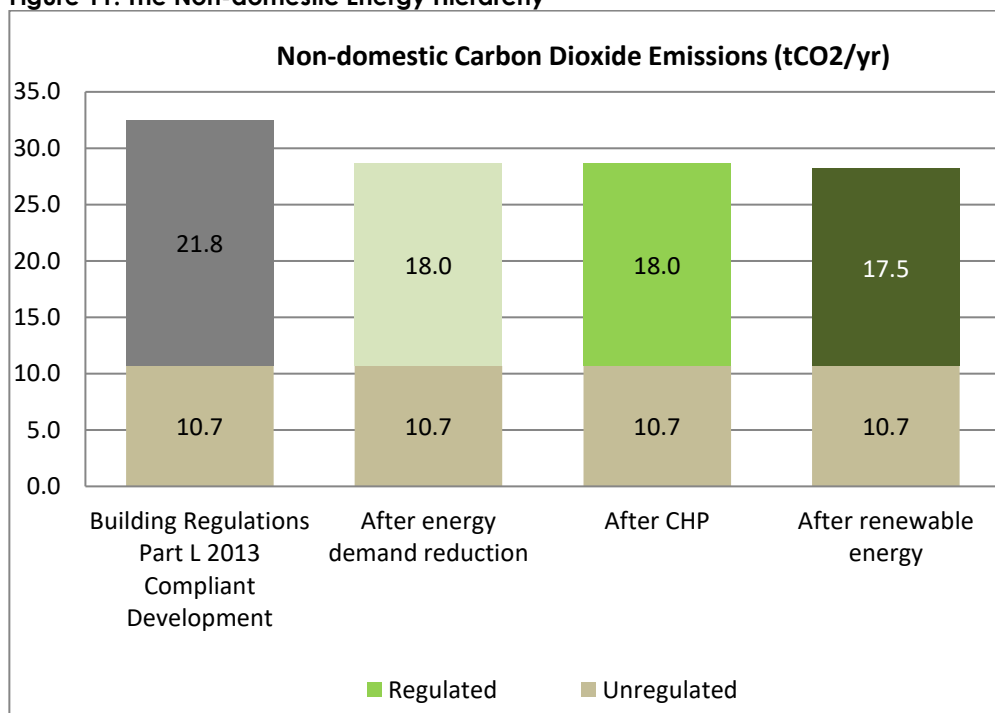
Table 24: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic

	Carbon dioxide emissions for non-domestic (Tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline: Part L 2013 of the Building Regulations Compliant Development	21.8	10.7	32.5
After energy demand reduction	18.0	10.7	28.7
After CHP	18.0	10.7	28.7
After renewable energy	17.5	10.7	28.2

Table 25: Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Savings from energy demand reduction	3.8	17.4%
Savings from CHP	0	0%
Savings from renewable energy	0.5	2.2%
Total cumulative on-site savings (non-residential)	4.3	19.7%

Figure 11: The Non-domestic Energy Hierarchy



9.3 Site Total CO₂ Emissions Savings

The development has been designed to show a total of **38.5 tCO₂** which equates to an overall **25.7% reduction** over Part L 2013. The following table shows a breakdown of the overall results.

Table 26: Site wide regulated carbon dioxide emissions and savings

	Total regulated emissions (Tonnes CO ₂ /year)	CO ₂ savings (Tonnes CO ₂ /year)	Percentage savings (%)
Part L baseline	149.9		
Be Lean	141.7	8.2	5.5%
Be Clean	111.9	29.8	19.9%
Be Green	111.4	0.5	0.33%
Total cumulative on site savings		38.5	25.7%

APPENDIX A
SAP INPUTS FOR RESIDENTIAL AREAS

Lean		Clean
Opaque Elements		
	U-value	
External Floors	0.11	
External Wall	0.15	
External Roof	0.12	
Doors	- (heated corridors)	
Openings (windows & glazed doors)		
U-value	1.4 (Double Glazed Units (DGUs))	
g-value	0.6	
Thermal Bridging		
y-value	y = 0.08 (Accredited Details)	
Ventilation		
	Natural vent (extract for wet rooms)	
Type	Mechanical Ventilation w/ Heat Recovery for units facing Friar St & Greyfriars Road up to 3 rd floor	
Manufacturer	Nuaire	
Model	MRXBOX95-WH1	
Air Permeability	5 m³/m²h	
Heating		
Heating Group	Community Heating Scheme	Community Heating Scheme
Heating Type	Community Boilers	Ener-G 35kW _{el} CHP + Community Boilers
Heating Fuel	Mains gas	Mains gas
Efficiency	Boilers=93%	CHP=50% _{th} 30% _{el} , Boilers=93%
CHP Heat to Power Ratio		1.6
Heat Fraction	Boilers= 1.0	CHP=0.5, Boilers=0.5
Heating Controls	Flat rate charging, programmer and TRVs	Flat rate charging, programmer and TRVs
Additional Heat Source		Boiler
Water Heating		
Water System	From Main Heating System	From Main Heating System
Heating Fuel	N/A	N/A
Efficiency	N/A	N/A
Heat Fraction	N/A	N/A
Heat-Power Ratio	N/A	N/A
Lighting		
% Low Energy lighting	100%	100%
Overheating		
Building Type	Single storey cross ventilation not possible	Single storey cross ventilation not possible
Window Opening	Windows full open (4ach)	Windows full open (4ach)

APPENDIX B
RESIDENTIAL COMPLIANCE REPORT (CLEAN)

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.3.15
Printed on 08 November 2016 at 12:39:10

Project Information:

Assessed By: ()

Building Type: Flat

Dwelling Details:

NEW DWELLING DESIGN STAGE

Total Floor Area: 63.61m²

Site Reference : 52-55 Friar St Clean

Plot Reference: A(2_05)

Address :

Client Details:

Name:

Address :

This report covers items included within the SAP calculations.

It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating system: Mains gas (c), Mains gas (c)

Fuel factor: 1.00 (mains gas (c), mains gas (c))

Target Carbon Dioxide Emission Rate (TER)

14.36 kg/m²

Dwelling Carbon Dioxide Emission Rate (DER)

10.55 kg/m²

OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)

27.6 kWh/m²

Dwelling Fabric Energy Efficiency (DFEE)

23.2 kWh/m²

OK

2 Fabric U-values

Element

Average

Highest

External wall

0.15 (max. 0.30)

0.15 (max. 0.70)

OK

Party wall

0.00 (max. 0.20)

-

OK

Floor

(no floor)

Roof

(no roof)

Openings

1.40 (max. 2.00)

1.40 (max. 3.30)

OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals

5.00 (design value)

Maximum

10.0

OK

4 Heating efficiency

Main Heating system:

Community heating schemes - mains gas

Secondary heating system:

None

5 Cylinder insulation

Hot water Storage:

No cylinder

6 Controls

Space heating controls

Charging system linked to use of community heating, programmer and TRVs OK

Hot water controls:

No cylinder

Regulations Compliance Report

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.5	
Maximum	1.5	OK
MVHR efficiency:	91%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (Thames valley):	Medium	OK
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Based on:

Overshading:	Average or unknown
Windows facing: West	2.28m ²
Windows facing: West	5.01m ²
Windows facing: West	2.28m ²
Windows facing: West	2.28m ²
Ventilation rate:	4.00
Blinds/curtains:	None
	Closed 100% of daylight hours

10 Key features

Thermal bridging	0.006 W/m ² K
Party Walls U-value	0 W/m ² K
Community heating, heat from boilers – mains gas	

DRAFT

APPENDIX C
IES MODELLING INPUTS FOR COMMERCIAL

Description	Units	Retail units
System	Description	VRF System + AHU
1. Construction U-values		
External Wall U-value	W/m ² K	0.18
Flat roof U-value	W/m ² K	0.18
Ground floor U-value	W/m ² K	0.18
Windows (incl frames) U-value	W/m ² K	1.40
Glass transmission g-value	g-value	0.40
3. Thermal bridging		
Thermal bridging allowance from cold bridges	W/m2K	10% of u-value
4. Air permeability		
Air leakage value	m ³ /m ² /h@50Pa	5
1. Heating		
Heating system type (assumed system in model)	Description	VRF
Heat Fuel Type	Elec/gas	Electricity
Heat generator seasonal efficiency	SCOP	4
Boiler installed on or after 1998?	Yes/No	-
Central Time Control?	Yes/No	No
Optimum start/stop control?	Yes/No	No
Local Time Control?	Yes/No	No
Local Temperature Control?	Yes/No	No
Weather Compensation Control?	Yes/No	No
Is there provision for metering?	Yes/No	Yes
Does the metering warn "out of range" values?	Yes/No	Yes
Pump type	fixed / variable speed	Constant speed
2. Cooling		
Cooling system type (assumed system in model)	Description	VRF
Nominal EER and Seasonal EER	EER & SEER	SEER 4 / EER 3.5
Does it Qualify for ECA?	Yes/No	-
Mixed mode? (CMM)	Description	-
3. Ventilation		
Ventilation Type	Description	AHU air distribution
Specific Fan power of air distribution plant	W/l/s	1.88 (includes heat recovery)
Demand controlled ventialtion	Occupancy or gas	No
Ductwork Leakage Classification	Type	-
AHU Leakage Classification	Type	-
Heat recovery	Type	Thermal Wheel
Heat recovery	% efficiency	75.0%
4. DHW		
DHW system type	Description	Instantaneous
DHW system delivery efficiency	%	100
DHW Fuel Type	Elec/gas	Electricity
Is the system a storage system?	Yes/No	Yes
Storage Volume	litres	250 litres
Insulation	Type	Factory fitted 100mm
Does the system have secondary circulation?	Yes/No	No
5. Lighting		
Averaged lighting power density across each zone type	W/m2/100lux or Luminaire lumens/circuit watt	1.8 W/m2/100lx
Lighting Controls	Local manual switching	No
Different sensor to back half of zone	Yes/No	No
Daylight sensing	Dimming / Switching	Dimming
Photo electric sensor type	Standalone / addressable	
Lighting Controls	Occupancy sensing	AUTO-ON-DIMMED (Foc = 0.95)
Energy Efficient Display Lighting	Yes/No	Yes (25lm/W)
Display lighting Time switch (20%)	Yes/No	Yes
Constant illuminane control (10%) saving	Yes/No	No
6. Building Management		
Electric Power Factor of the building	Power Factor Control	>0.95
Lighting systems have provision for metering?	Yes/No	Yes
Lighting systems metering warns of 'out of range' values?	Yes/No	Yes
7. LZC technologies		
Renewable technologies	Description	None
Renewable technologies	Description	None

APPENDIX D

COMMERCIAL AREAS COMPLIANCE REPORT (BRUKL – GREEN)

Project name

52-55 Friar St_Retail Green_Oct 2016

As designed

Date: Thu Oct 27 16:53:33 2016

Administrative information

Building Details

Address: 52-55 Friar St, Reading, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO₂ emission rate for the building should not exceed the target

1.1	CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	35.3
1.2	Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	35.3
1.3	Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	28.6
1.4	Are emissions from the building less than or equal to the target?	BER ≤ TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	CL000003:Surf[0]
Floor	0.25	0.18	0.18	CL000003:Surf[10]
Roof	0.25	-	-	UNKNOWN
Windows***, roof windows, and rooflights	2.2	1.43	1.43	CL000003:Surf[5]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
U _a -Limit = Limiting area-weighted average U-values [W/(m ² K)] U _a -Calc = Calculated area-weighted average U-values [W/(m ² K)] U _i -Calc = Calculated maximum individual element U-values [W/(m ² K)] * There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	5

2.b Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- VRF

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.5	0	0	0.75
Standard value	2.5*	3.2	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

1- Instantaneous hot water

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	1	N/A

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting		Luminous efficacy [lm/W]			General lighting [W]
Zone name		Luminaire	Lamp	Display lamp	
	Standard value	60	60	22	
C Level 00 Retail		-	76	25	5946
A Level 00 Retail		-	82	25	1511

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
C Level 00 Retail	NO (-30.8%)	NO
A Level 00 Retail	NO (-3.2%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m ²]	621.4	621.4
External area [m ²]	917.9	917.9
Weather	LON	LON
Infiltration [m ³ /hm ² @ 50Pa]	5	3
Average conductance [W/K]	269.22	326.79
Average U-value [W/m ² K]	0.29	0.36
Alpha value* [%]	10	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area Building Type

100	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	1.75	1.99
Cooling	8.74	8.44
Auxiliary	8.82	4.01
Lighting	35.18	54.21
Hot water	2.07	1.86
Equipment*	20.25	20.25
TOTAL **	56.57	70.51

* Energy used by equipment does not count towards the total for calculating emissions.

** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	112.82	133.46
Primary energy* [kWh/m ²]	174.55	213.47
Total emissions [kg/m ²]	28.6	35.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance										
System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER	
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	23.5	89.4	1.7	8.7	8.8	3.73	2.84	4	4
	Notional	18.3	115.2	2	8.4	4	2.56	3.79	----	----

Key to terms

- Heat dem [MJ/m2] = Heating energy demand
- Cool dem [MJ/m2] = Cooling energy demand
- Heat con [kWh/m2] = Heating energy consumption
- Cool con [kWh/m2] = Cooling energy consumption
- Aux con [kWh/m2] = Auxiliary energy consumption
- Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
- Cool SSEER = Cooling system seasonal energy efficiency ratio
- Heat gen SSEFF = Heating generator seasonal efficiency
- Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
- ST = System type
- HS = Heat source
- HFT = Heating fuel type
- CFT = Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.18	CL000003:Surf[0]
Floor	0.2	0.18	CL000003:Surf[10]
Roof	0.15	-	UNKNOWN
Windows, roof windows, and rooflights	1.5	1.43	CL000003:Surf[5]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)]			U _{i-Min} = Minimum individual element U-values [W/(m²K)]
* There might be more than one surface where the minimum U-value occurs.			

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

APPENDIX E
CHP SPECIFICATION

General Description:

- Fuel Type:	Natural Gas
- Minimum Methane Number:	80
- Electrical Output:	25 kW
- Heat Output (Exhaust Cooled to 124°C):	38 kW
- Fuel Input Net/Gross (CV 10 kWh/Nm ³):	75/82 kW
- Min/Max Dynamic Gas Pressure:	15/30 mbar
- Max Return/Flow Water Temp:	75/ 85 °C
- Unit Efficiency:	85.2 %

Prime Mover:

- Type:	Reciprocating Engine
- Combustion Cycle:	4-stroke Spark Ignition
- Cylinders:	4
- Speed:	1900
- NOx Emissions:	542 mg/Nm ³
- CO Emissions:	634 mg/Nm ³
- Aspiration:	Natural

Generator:

- Type:	PMG DC & DC/AC Inverter
- Frequency:	50 Hz
- Voltage:	400 V
- Phase(s):	3-Phase

Heat Recovery System:

- Fully closed primary water circuit.
- Exhaust gas heat exchanger in primary circuit.
- PHE between primary & secondary circuits.
- Primary water pump.
- Auto heat output modulation.

Control & Protection:

- On board computer control, protection and monitoring.
- Engine stop/start, synchronising, modulation.
- Mechanical, electrical and thermal protection.
- BMS interface signals.

Standard Equipment:

- Internal Exhaust silencers.
- Secondary water pump.

Optional Equipment / Configuration:

- Export control panel.
- Remote monitoring.
- Heat and gas metering.
- System controller.
- Anti-vibration mounts.
- Exhaust extension kit.

- Electrical output is based on output at the generator terminals at a power factor of 0.95.
 - Energy quantities subject to reduction when modulating in response to external conditions.
 - We reserve the right to alter the Engine Type, at any time, to meet the system specifications.
 - Performance figures are subject to original Engine manufacturer's declared performance, tolerances and test conditions.
 - Output figures are based on operation at ISO3046 conditions with the exception of the exhaust output, temperature stated above.
 - Technical Datasheets are subject to change, without notice, due to our commitment to on-going product improvement.

APPENDIX F
CHPQA PROGRAMME LIST

CHPQA UNIT LIST



Only CHP units meeting the following criteria can be placed on the list:

- CHP Total Power Capacity (CHP_{TPC}) less than $500kW_e$,
- No in-built facility to dump heat,
- Only include a single Reciprocating Engine
- Use only Natural Gas fuel
- One main heat output system e.g. a single system recovering heat from the engine cooling systems and exhaust gases.

Note: CHPQA Unit list allows small engine based CHP schemes (<500 kWe) to check their performance against the design performance of the relevant unit and under specified conditions to use the efficiency information in estimating the fuel input and/or heat output on their CHPQA submission. This is not a list of approved or certified CHP units, and it is not a means of gaining type approval nor is it an "ECA approved list". Suppliers/Manufacturers wishing to add a particular unit to the list should contact the CHPQA Administrator for details of the procedures to be followed.

MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
ABB	Zantec 476	Waukesha	476	734	1377	34.6%	1.54	53.3%	87.9%
AIRCOGEN	Nimbus 63	GM 7400	63	120	223	28.3%	1.91	53.8%	82.1%
	Nimbus 104	MAN E0836 LE202	104	127	310	33.5%	1.22	41.0%	74.5%
	Nimbus 200	MAN E2876 LE302	200	233	592	33.8%	1.17	39.4%	73.1%
	Nimbus 238	MAN E2842 E312	238	359	734	32.4%	1.51	48.9%	81.3%
	Nimbus 309	Perkins 4006TESI 140HC	309	405	946	32.7%	1.31	42.8%	75.5%
	Nimbus 415	Perkins 4008TESI 140HC	415	549	1273	32.6%	1.32	43.1%	75.7%
BOSCH THERMOTECHNOLOGY	CE19 N	Volkswagen 2.0	19	31	60	31.7%	1.63	51.7%	83.3%
	CE50 N	MAN E0834 E302	50	80	164	30.5%	1.60	48.8%	79.3%
	CE70 N	MAN E0836 E302	70	109	226	31.0%	1.56	48.2%	79.2%
	CE140 N	MAN E2876 E312	140	212	426	32.9%	1.51	49.8%	82.6%
	CE240 N	MAN E2842 E312	240	374	743	32.3%	1.56	50.3%	82.6%

CHPQA UNIT LIST



MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
COGENCO	CGC-0030MA	MAN E0834 E312	30	47	111	27.0%	1.57	42.3%	69.4%
	CGC-0050MA	MAN E0834 E302	50	79	182	27.5%	1.58	43.4%	70.9%
	CGC-0070MA	MAN E0836 E302	70	109	225	31.1%	1.56	48.4%	79.6%
	Nedalo	MAN E2866E	95	143	300	31.7%	1.51	47.7%	79.3%
	CGC-0100MA	MAN E2876E312	100	171	343	29.2%	1.71	49.9%	79.0%
	Nedalo	MAN E2866E302	112	177	373	30.0%	1.58	47.5%	77.5%
	CGC-0112MA	MAN E2866 E302	112	178	379	29.6%	1.59	47.0%	76.6%
	CGC -0120MA	MAN E2876 E312	120	192	397	30.2%	1.60	48.4%	78.6%
	CGC-0121CC-080	CACR6	121	198	401	30.2%	1.64	49.4%	79.6%
	CGC-0167MA	MAN E2842 E	167	260	543	30.8%	1.56	47.9%	78.7%
	Nedalo	MAN E2842E	168	261	542	31.0%	1.55	48.2%	79.2%
	CGC 0198	MAN E2876 LE302	198	233	599	33.1%	1.18	38.9%	72.0%
	CGC-0200MA	MAN E2876 LE302	200	242	601	33.3%	1.21	40.3%	73.5%
	CGC-0210MA	MAN E2842 E302	210	319	684	30.7%	1.52	46.6%	77.3%
	Nedalo	MAN E2842E302	211	321	681	31.0%	1.52	47.1%	78.1%
	CGC 0238	MAN E2842 E312	238	365	740	32.2%	1.53	49.3%	81.5%
	CGC-250MA	MAN E2848 LE322	250	321	762	32.8%	1.28	42.1%	74.9%
	CGC-0300GU-075	Guascor SFGLD 180	300	438	910	33.0%	1.46	48.1%	81.1%
	Nedalo	Perkins 4006TESI LC	306	469	1020	30.0%	1.53	46.0%	76.0%

CHPQA UNIT LIST



MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
COGENCO	CGC 0307	Perkins 4006	307	435	990	31.0%	1.42	43.9%	74.9%
	CGC-0307PE	Perkins 4006-23 TRS1	307	357	912	33.7%	1.16	39.1%	72.8%
	CGC 0312	MAN 2842 LE302	312	433	990	31.5%	1.39	43.7%	75.3%
	CGC-0342MA-080	MAN E2842LE312	342	422	1040	32.9%	1.23	40.6%	73.5%
	CGC-0375PE	Perkins 4006-23 TRS2	375	401	1088	34.5%	1.07	36.9%	71.3%
	CGC 0380	MAN E2842 LE312	380	500	1142	33.3%	1.32	43.8%	77.1%
	CGC-0380MA	MAN E2842 LE312	380	455	1142	33.3%	1.20	39.8%	73.1%
	CGC-0400GU	Guascor SFGLD 240	400	465	1246	32.1%	1.16	37.3%	69.4%
	CGC-0400MA	MAN E2842 LE322	400	513	1163	34.4%	1.28	44.1%	78.5%
	Nedalo	Perkins 4008 TESILC	409	633	1363	30.0%	1.55	46.4%	76.4%
	CGC-0425PE	Perkins 4008-30 TRS1	425	551	1245	34.1%	1.30	44.3%	78.4%
	CGC 0490 L	CAT G3508 LE	490	679	1491	32.9%	1.39	45.5%	78.4%
	CGC 500 GU	Guascor HGM240	500	512	1362	36.7%	1.02	37.6%	74.3%
	CGC-0501PE-080	Perkins 4008-30 TRS2	501	518	1444	34.7%	1.03	35.9%	70.6%
ENER-G	YANMAR 25	4GPF98-C1	25.1	38.4	82.4	30.5%	1.53	46.6%	77.1%
	EnerG 35M	E 0834 E 302	33	55	—		1.67		
	EnerG 35	E 0834 E 302	35	61	123	28.5%	1.75	49.9%	78.5%
	CPL 4Fg	Ford BSD444	38	70	152	25.0%	1.84	46.1%	71.1%
	EnerG 50	E 0834 E 302	50	79	164	30.5%	1.58	48.3%	78.8%

CHPQA UNIT LIST



MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
ENER-G	CPL 6NFg	Ford BSD666	54	97	200	27.0%	1.80	48.5%	75.5%
	EnerG 60	Man E0836	60	89	193	31.1%	1.48	46.1%	77.2%
	6MRg	Man E0836	60	90	200	30.0%	1.50	45.0%	75.0%
	EnerG 70	E 0836 E 302	70	109	226	31.0%	1.56	48.3%	79.3%
	CPL 6Fg	Ford BSD678	75	130	259	29.0%	1.73	50.2%	79.2%
	EnerG 75P	EGE-06L	75	143	262	28.6%	1.91	54.6%	83.3%
	EnerG 90	EGE-06L	90	161	308	29.2%	1.79	52.2%	81.4%
	CPL 6Mg	MAN E2866E	95	143	317	30.0%	1.51	45.1%	75.1%
	EnerG 100	EGE-06L	100	172	335	29.9%	1.72	51.5%	81.4%
	CPL 6M+g	MAN E2866E302	110	177	367	30.0%	1.61	48.2%	78.2%
	EnerG 110	MWB G6R183A	110	177	356	30.9%	1.61	49.7%	80.6%
	CPL 6Pg	Perkins 2006	110	180	393	28.0%	1.64	45.8%	73.8%
	EnerG 110	EGE-06L	110	184	362	30.4%	1.67	50.9%	81.3%
	EnerG 120	EGE-06L	120	196	389	30.9%	1.63	50.3%	81.2%
	EnerG 122	MWB G6V183A	122	196	395	30.9%	1.61	49.6%	80.5%
	EnerG 125	EGE-06L	124	200	399	31.1%	1.61	50.1%	81.1%
	EnerG 135	EGE-08V	135	217	434	31.1%	1.61	50.2%	81.3%
	CPL 8Pg	Perkins 2008	145	265	518	28.0%	1.83	51.2%	79.2%
	EnerG 150	MWB G8V183A	152	231	474	32.1%	1.52	48.7%	80.8%

CHPQA UNIT LIST



MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
ENER-G	EnerG 150	EGE-08V	152	236	478	31.8%	1.55	49.4%	81.2%
	EnerG 165	EGE-12V	165	286	550	30.0%	1.73	52.0%	82.0%
	CPL 12Mg	MAN E2842E	168	261	542	31.0%	1.55	48.2%	79.2%
	EnerG 185	EGE-12V	185	309	603	30.7%	1.67	51.3%	82.0%
	EnerG 200	E 2876 LE 302	201	263	595	33.8%	1.31	44.2%	78.0%
	CPL 12M+g	MAN E2842E302	206	321	665	31.0%	1.56	48.3%	79.2%
	EnerG 210	EGE-12V	210	337	669	31.4%	1.61	50.4%	81.9%
	CPL 12Pg	Perkins 3012	220	385	880	25.0%	1.75	43.8%	68.8%
	EnerG 230	MWB G12V183A	228	347	718	31.8%	1.52	48.3%	80.1%
	EnerG 230	EGE-12V	229	358	718	31.9%	1.56	49.9%	81.8%
	EnerG 300	MAN	300	445	1111	27.0%	1.48	40.1%	67.1%
	EnerG 305	Perkins 4006TESILC	305	432	976	31.3%	1.42	44.3%	75.5%
	EnerG 310	4006-23 TRS1	310	357	907	34.2%	1.15	39.4%	73.5%
	EnerG 375	4006-23 TRS2	378	401	1082	34.9%	1.06	37.1%	72.0%
	EnerG 380	E 2842 LE 312	384	467	1137	33.8%	1.22	41.1%	74.8%
	EnerG 425	4008-30 TRS1	430	468	1238	34.7%	1.09	37.8%	72.6%
	EnerG 500	Perkins 4008TRS2	500	516	1436	34.8%	1.03	35.9%	70.8%

CHPQA UNIT LIST



MANUFACTURER	MODEL	Engine	Total Power Capacity kW	Total Heat Capacity kW	Fuel Input kW (GCV)	Power Efficiency	Max Heat to Power Ratio	Max Heat Efficiency	Max Overall Efficiency
FRICHS	Valmet	Mini 420 G	22	55	85	25.9%	2.50	64.7%	90.6%
	Valmet	Mini 420 G	30	70	118	25.4%	2.33	59.3%	84.7%
	Valmet	Mini 634 G	60	125	206	29.1%	2.08	60.7%	89.8%
JENBACHER	GE Jenbacher	Type 208	330	361	853	38.7%	1.09	42.3%	81.0%
PERKINS	Perkins (or Dorman)	4006TESI HC 90	309	494	1001	30.9%	1.60	49.4%	80.2%
PERKINS	Perkins (or Dorman SETCWG)	4006TESI HC 140	309	439	968	31.9%	1.42	45.4%	77.3%
		4006TESI LC 140	309	466	1036	29.8%	1.51	45.0%	74.8%
		4006TESI LC 200	309	432	989	31.2%	1.40	43.7%	74.9%
		4008TESI HC 90	415	619	1312	31.6%	1.49	47.2%	78.8%
		4008TESI HC 140	415	594	1283	32.3%	1.43	46.3%	78.6%

1. Brake power tested to ISO 3046. All figures are obtained from the manufacturer's technical specification.
2. The maximum usable heat output at full load operation, equal to the sum of the Heat output from the jacket water, oil and from the exhaust gases (down to exhaust gas discharge temperature of 120 Degrees Centigrade) where the heat output is in the form of Low Temperature Hot Water (up to 100 Degrees Centigrade). All figures are obtained from the manufacturer's technical specification.
3. Based on Gross Calorific Value. All figures are obtained from the manufacturer's technical specification.
4. Highlighted units were added on or after November 2012.
5. Some performance corrections were made made for some previous units.

APPENDIX G
EXISTING UTILITIES SEARCH

Existing Utilities Searches

52-55 Friar Street & 12 Grey Friars Road
Reading

Date: November 2016

Issue: P1

Reference: PUR10203

Status: Planning

Prepared by: NB/AD

Date: 24/11/16

Edited by: NB/AD

Date: 24/11/16

Authorised by: NB

Date: 24/11/16

Issuing office: Purley

DOCUMENT CONTROL

Issue	Date	Status	HPF Author (Date/Initials)	HPF Approval (Date/Initials)	Notes
P1	24/11/16	Planning	24/11/16_NB/AD	24/11/16_NB	

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1.0 INTRODUCTION

A general search of existing utility services in the vicinity of the site has been carried out and responses of drawings providing approximate service positions from the affected utility companies are included within this report.

The affected utility companies are as follows:

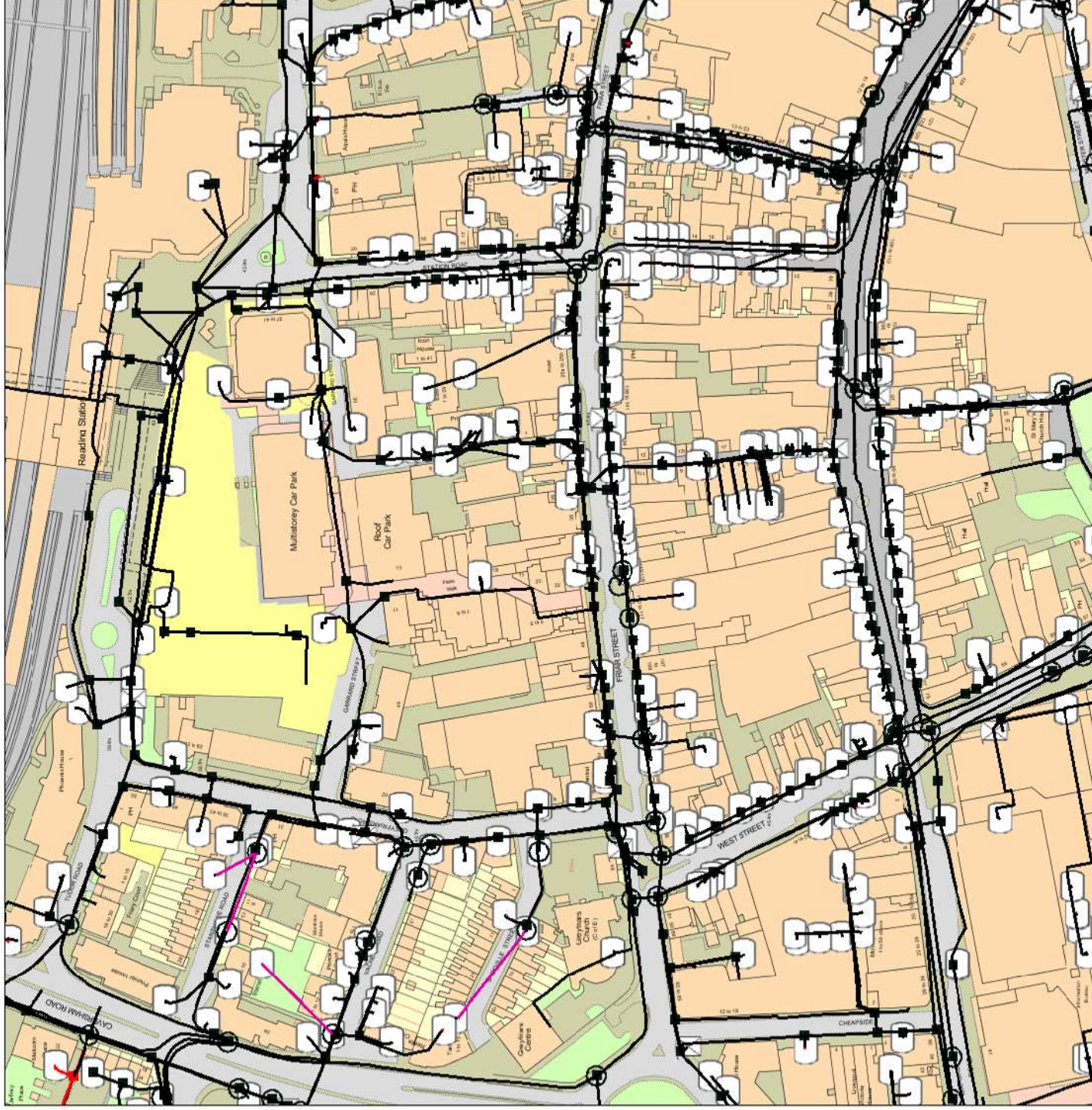
- BT Open Reach
- Level 3, Global Crossing (UK) Ltd / Fibernet UK Ltd
- Scottish & Southern Energy (HV mains)
- Thames Water (Sewers)
- Thames Water (Water)
- Vodafone
- Southern Gas Network
- Ofcom

Other utility companies that have advised of not being affected by the proposed development are:

- BSKYB
- City Fibre
- Fulcrum (Gas)
- GTC (Gas / Electricity)
- Interoute
- Linesearch / National Grid (Gas / Electricity)
- Network Rail
- Telent / Teliasonera
- Trafficmaster
- Verizon
- Vtesse

1.1 BT Open Reach

Maps by email Plant Information Reply



IMPORTANT WARNING

Information regarding the location of BT apparatus is given for your assistance and is intended for general guidance only. No guarantee is given of its accuracy. It should not be relied upon in the event of excavations or other works being made near to BT apparatus which may exist at various depths and may deviate from the marked route.

DIAL BEFORE YOU DIG

FOR PROFESSIONAL ON SITE ASSISTANCE PRIOR TO COMMENCEMENT OF EXCAVATION WORKS

ADVANCE NOTICE REQUIRED
(Office hours: Monday-Friday 08.00 to 17.00)

Tel: 0800 9173993
E-mail: dbyd@openreach.co.uk
Website: www.dialbeforeyoudig.com

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KEY TO BT SYMBOLS

UNDERGROUND PLANT	POLE
A/C, D/W or W	CABINET
JOINT BOX	BURIED JOINT
DISTRIBUTION POINT	JOINTING POST
MANHOLE	PROPOSED U/G
DP BOUNDARY	PROPOSED O/H
OTHER BT BOUNDARY	PROPOSED BOX

Other proposed plant is shown using dashed lines. BT symbols not listed above may be disregarded. Existing BT plant may not be recorded. Information valid at the time of preparation.

openreach
a BT Group business

BT Ref : KY09129J

Map Reference : (centre) SU7138073605

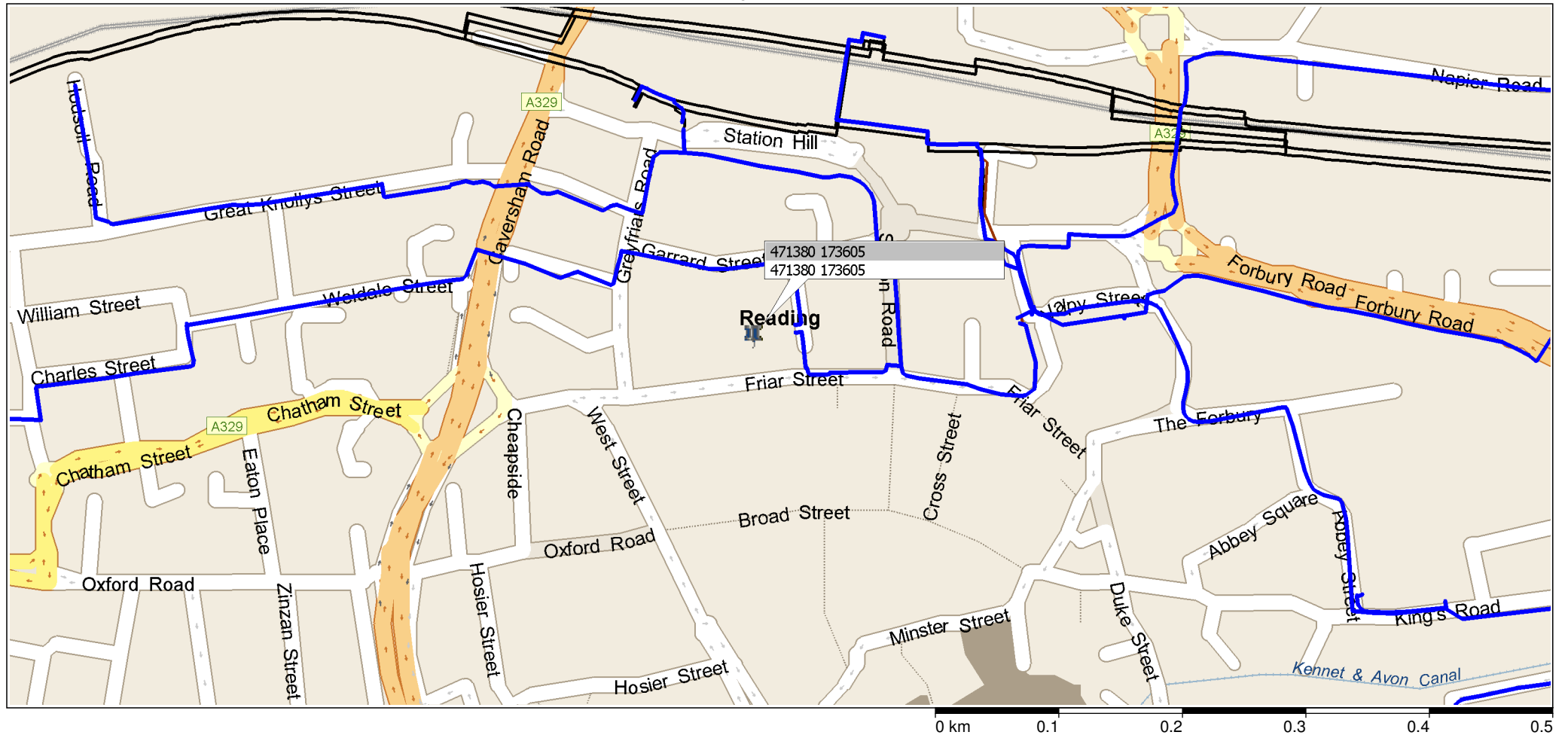
Easting/Northing : (centre) 471380, 173605

Issued : 04/11/2015 09:13:00

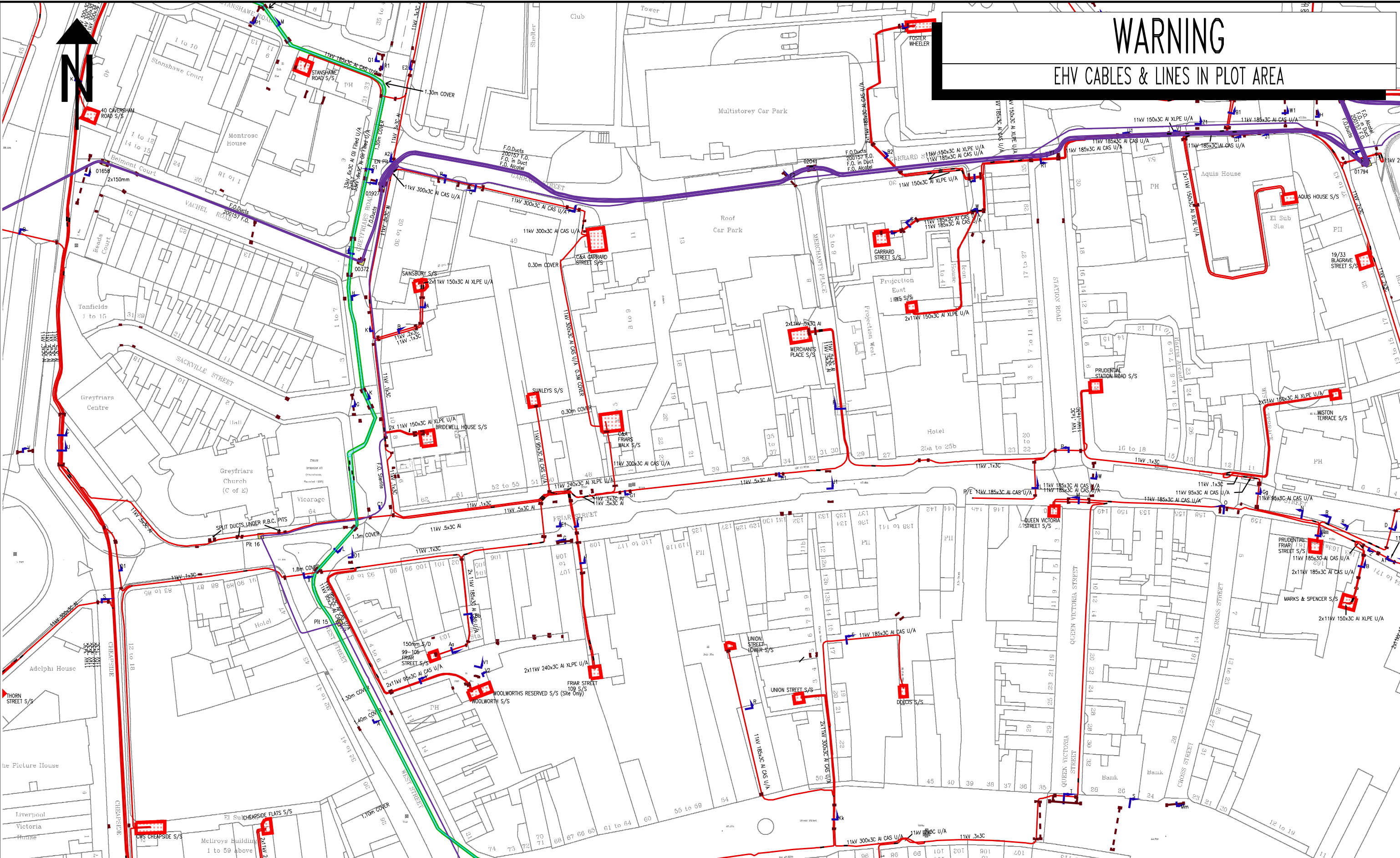
FOOTNOTE: WARNING IT IS ESSENTIAL THAT YOU CONTACT NATIONAL NETWORK HANDLING CENTRE BY EMAIL nnhc@openreach.co.uk BEFORE PROCEEDING WITH ANY WORK IN THE HATCHED AREA

1.2 Level 3, Global Crossing (UK) Ltd / Fibernet UK Ltd

GC & Fibernet as-built map (Version 6.0) - 30-01-12 - New



1.3 Scottish & Southern Energy (HV mains)



NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID				
	services	l.v.	h.v.	e.h.v.
FOOTPATH	0.40m	0.45m	0.60m	0.75m
ROAD CROSSING	0.60m	0.60m	0.75m	0.90m
l.v./services	- up to 1000V.			
h.v.	- over 1000V. to 11,000V.			
e.h.v.	- 22,000V. to 132,000V.			

WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depth of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. (available from HMSO)

WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE G36 SHOULD BE CONSULTED. (AVAILABLE FROM HMSO)

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Template: S1AS HPSWA COL A3 plot

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200 Dunkeld Road,
Perth, PH1 3AQ.

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Scottish and Southern Energy

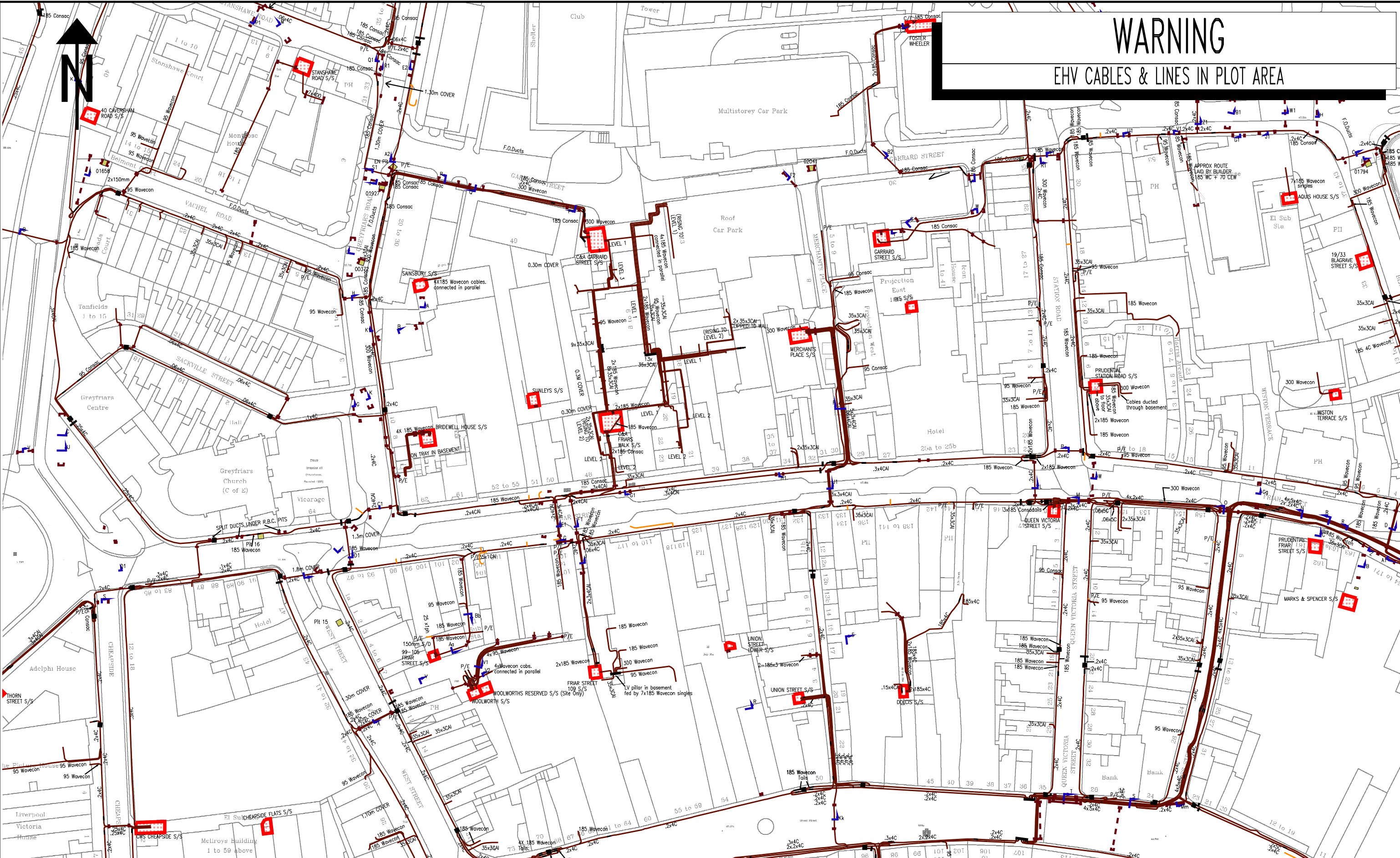
H.V. MAINS RECORD

READING
01189-126500

Grid Ref: SU71387360

Scale: 1:1250

Date: 04/11/2015



NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID				
	services	l.v.	h.v.	e.h.v.
FOOTPATH	0.40m	0.45m	0.60m	0.75m
ROAD CROSSING	0.60m	0.60m	0.75m	0.90m
l.v./services	- up to 1000V.			
h.v.	- over 1000V. to 11,000V.			
e.h.v.	- 22,000V. to 132,000V.			

WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depth of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. (available from HMSO)

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Perth, PH1 3AQ.

UR05084.1DM

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Scottish and Southern Energy

L.V. MAINS RECORD

READING
01189-126500

Grid Ref: SU71387360

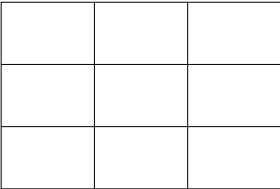
Scale: 1:1250

Date: 04/11/2015



GIS SYMBOLS (SOUTH)

	LV UNDERGROUND SERVICE CABLE
	LV UNDERGROUND MAINS CABLE
	2KV-3.3KV UNDERGROUND CABLE
	6.6KV UNDERGROUND CABLE
	11KV UNDERGROUND CABLE
	22KV UNDERGROUND CABLE
	33KV UNDERGROUND CABLE
	66KV UNDERGROUND CABLE
	132KV UNDERGROUND CABLE
	LV OVERHEAD LINE
	2-3.3KV OVERHEAD LINE
	6.6KV OVERHEAD LINE
	11KV OVERHEAD LINE
	22KV OVERHEAD LINE
	33KV OVERHEAD LINE
	66KV OVERHEAD LINE
	132KV OVERHEAD LINE
	FIBRE OPTIC CABLE
	PILOT CABLE
	CIRCUIT BREAKER
	SWITCH DISCONNECTOR
	POLE BOX
	POLE MOUNTED TRANSFORMER
	SUBSTATION
	LINK BOX
	PILLAR
	MAJOR PIPELINE



 Scottish and Southern Energy plc.

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DATE: 14/06/2006

Subject to Revision
Master held at

SCALE: 1:500

Mapping Services Unit 01256 337294

INTERNAL USE ONLY

1.4 Thames Water (Sewers)

Asset Location Search Sewer Map - ALS/ALS Standard/2015 3184507



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 471394,173589

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

	Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.
	Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.
	Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.
	Trunk Surface Water
	Trunk Foul
	Storm Relief
	Trunk Combined
	Vent Pipe
	Bio-solids (Sludge)
	Proposed Thames Surface Water Sewer
	Proposed Thames Water Foul Sewer
	Gallery
	Foul Rising Main
	Surface Water Rising Main
	Combined Rising Main
	Sludge Rising Main
	Proposed Thames Water Rising Main
	Vacuum

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
- 5) 'na' or '0' on a manhole level indicates that data is unavailable.

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

	Air Valve
	Dam Chase
	Fitting
	Meter
	Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

	Control Valve
	Drop Pipe
	Ancillary
	Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

	Outfall
	Undefined End
	Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

	Public/Private Pumping Station
	Change of characteristic indicator (C.O.C.I.)
	Invert Level
	Summit

Areas

Lines denoting areas of underground surveys, etc.

	Agreement
	Operational Site
	Chamber
	Tunnel
	Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

	Foul Sewer
	Surface Water Sewer
	Combined Sewer
	Gully
	Culverted Watercourse
	Proposed
	Abandoned Sewer

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

1.5 Thames Water (Water)

Asset Location Search Water Map - ALS/ALS Standard/2015 3184507



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 471394, 173589.
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

- 4"** **Distribution Main:** The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.
- 16"** **Trunk Main:** A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.
- 3" SUPPLY** **Supply Main:** A supply main indicates that the water main is used as a supply for a single property or group of properties.
- 3" FIRE** **Fire Main:** Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.
- 3" METERED** **Metered Pipe:** A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.
- Transmission Tunnel:** A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.
- Proposed Main:** A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

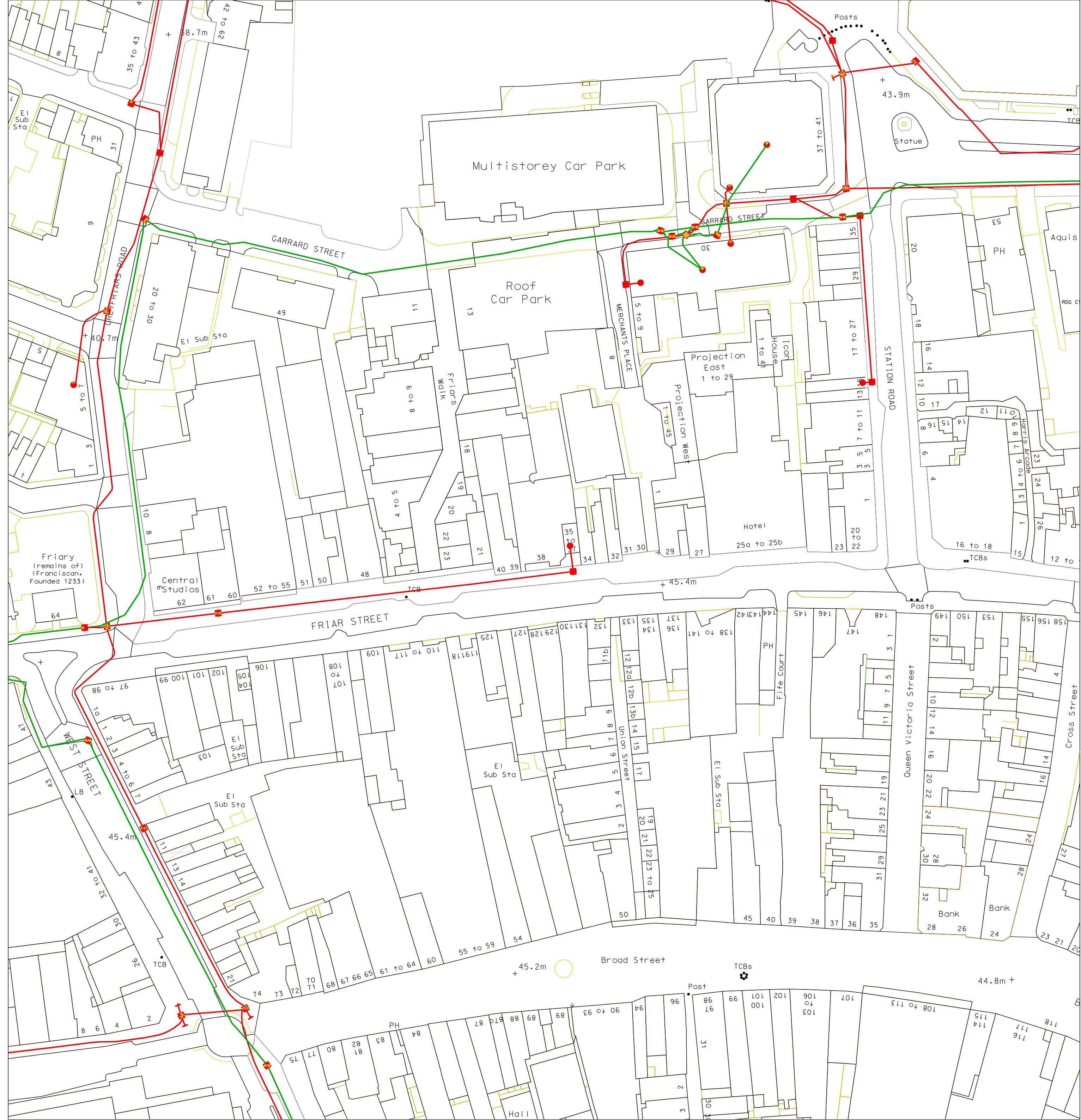
Other Symbols

- Data Logger

Other Water Pipes (Not Operated or Maintained by Thames Water)

- Other Water Company Main:** Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.
- Private Main:** Indicates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

1.6 Vodafone



Map1

Plant

AsBuilt Ducts (UNC use only)

Leased

Owned

Shared

Shared (SP)

AsBuilt Chambers

Plan Ducts

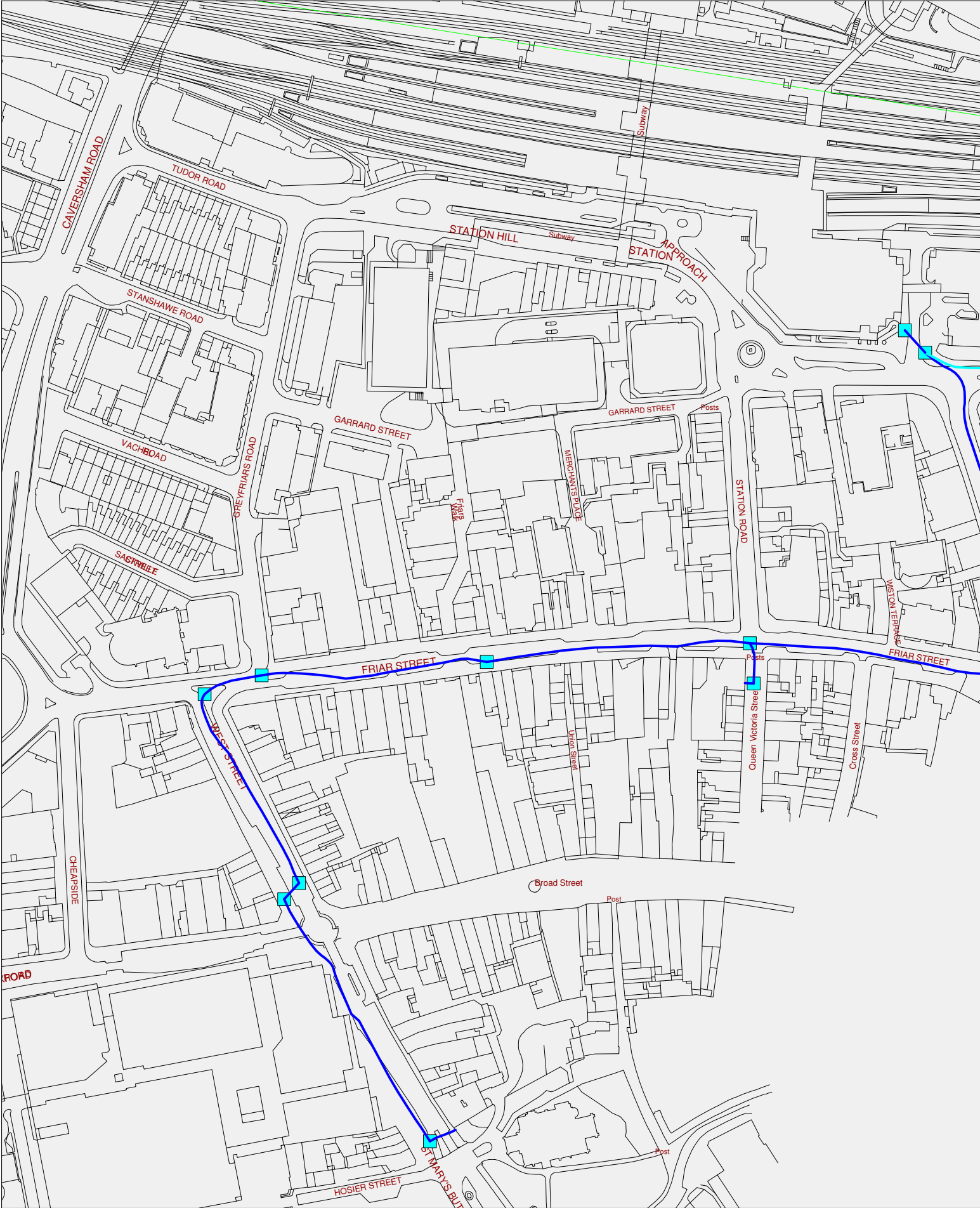
Plan Chambers

Land-Line

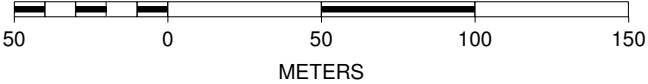
Abc

Street Names

Street Mapping (High Detail)

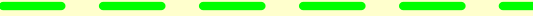
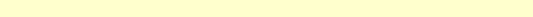
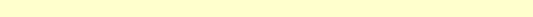
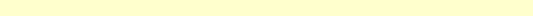


SCALE 1 : 2,449





Vodafone Network Colour:

	Ex-Cable&Wireless UK Network (now Vodafone)
	Planned & Approved Route
	Planned Route – Awaiting Approval
	Other Licensed Operator (OLO)
	Ex-Thus Network (now Vodafone)
	Ex-Energis Network (now Vodafone)
	OLO

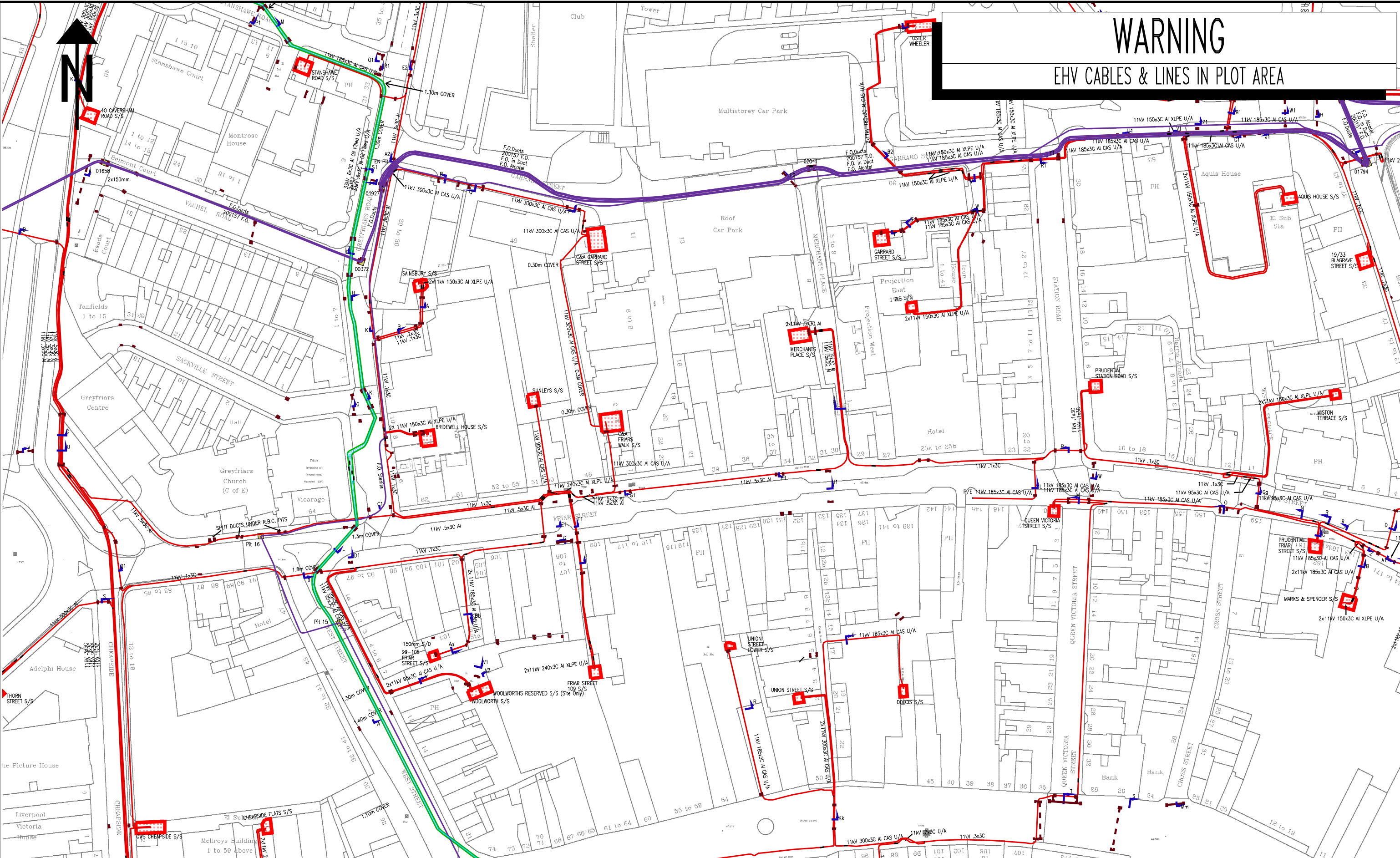
Other:

	Overhead Electricity Line (non Vodafone)
	Network Rail

Other Licensed Operator (OLO).

= Ex-Cable&Wireless UK, Energis and Thus fibre-optic cable within an OLO duct. Please contact all other operators for further details of their apparatus within that area.

1.7 Southern Gas Network



NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID				
	services	l.v.	h.v.	e.h.v.
FOOTPATH	0.40m	0.45m	0.60m	0.75m
ROAD CROSSING	0.60m	0.60m	0.75m	0.90m
l.v./services	- up to 1000V.			
h.v.	- over 1000V. to 11,000V.			
e.h.v.	- 22,000V. to 132,000V.			

WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depth of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. (available from HMSO)

WHEN WORKING IN THE VICINITY OF OVERHEAD LINES THE HEALTH AND SAFETY GUIDANCE NOTE G36 SHOULD BE CONSULTED. (AVAILABLE FROM HMSO)

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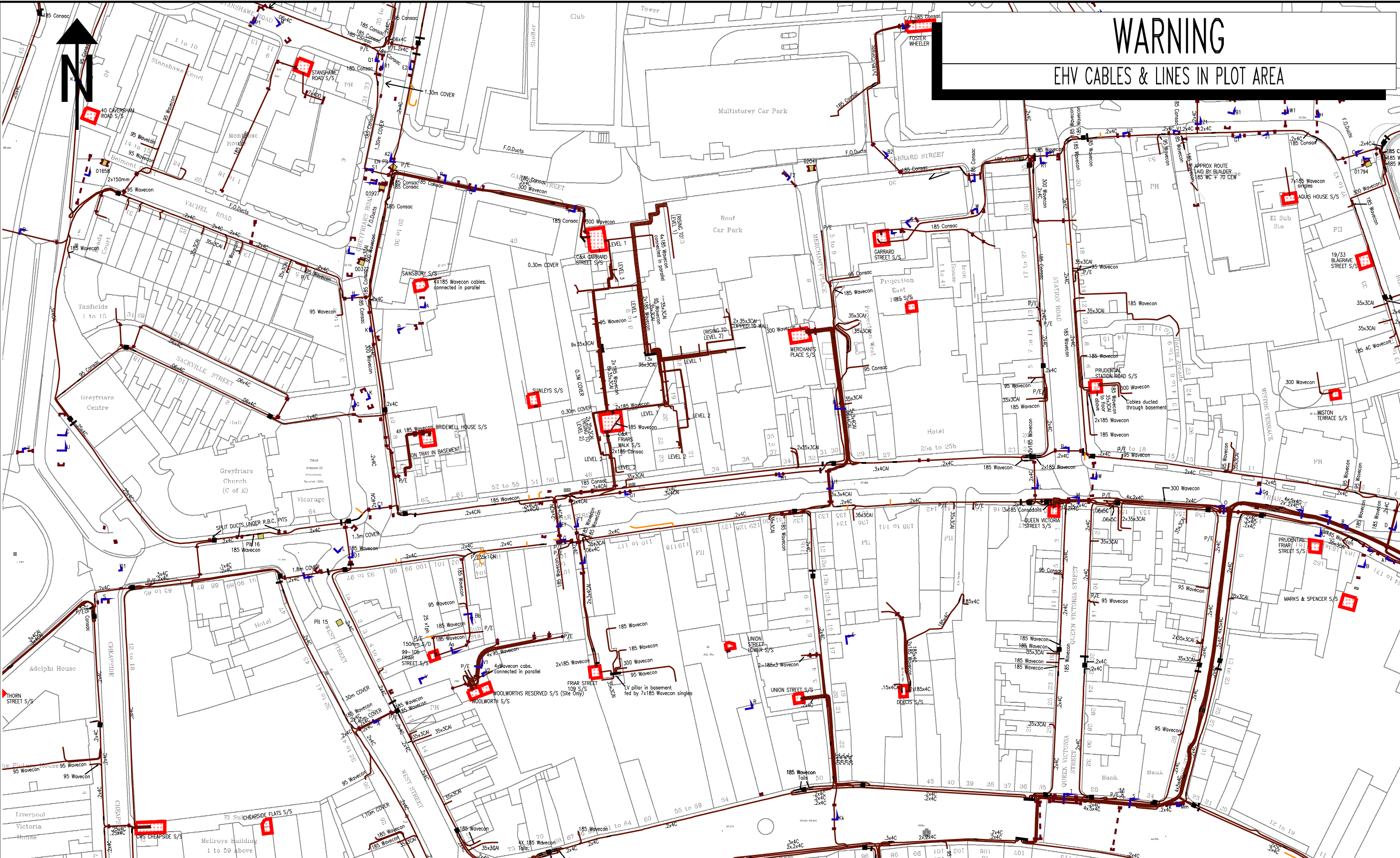
READING

01189-126500

Grid Ref: SU71387360

Scale: 1:1250

Date: 04/11/2015



NORMAL DEPTH TO THE TOP OF THE CABLE WHEN LAID				
	services	l.v.	h.v.	e.h.v.
FOOTPATH	0.40m	0.45m	0.60m	0.75m
ROAD CROSSING	0.60m	0.60m	0.75m	0.90m
l.v./services	- up to 1000V.			
h.v.	- over 1000V. to 11,000V.			
e.h.v.	- 22,000V. to 132,000V.			

WARNING

There may have been subsequent alterations to the surface levels. Trial holes must be taken to determine positions and depth of cables. HS (G) 47 Booklet from the Health and Safety Executive - Avoiding Danger from Buried Cables - should be consulted before commencing excavation work. (available from HMSO)

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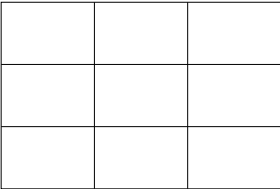
Scale: 1:1250

Date: 04/11/2015



GIS SYMBOLS (SOUTH)

	LV UNDERGROUND SERVICE CABLE
	LV UNDERGROUND MAINS CABLE
	2KV-3.3KV UNDERGROUND CABLE
	6.6KV UNDERGROUND CABLE
	11KV UNDERGROUND CABLE
	22KV UNDERGROUND CABLE
	33KV UNDERGROUND CABLE
	66KV UNDERGROUND CABLE
	132KV UNDERGROUND CABLE
	LV OVERHEAD LINE
	2-3.3KV OVERHEAD LINE
	6.6KV OVERHEAD LINE
	11KV OVERHEAD LINE
	22KV OVERHEAD LINE
	33KV OVERHEAD LINE
	66KV OVERHEAD LINE
	132KV OVERHEAD LINE
	FIBRE OPTIC CABLE
	PILOT CABLE
	CIRCUIT BREAKER
	SWITCH DISCONNECTOR
	POLE BOX
	POLE MOUNTED TRANSFORMER
	SUBSTATION
	LINK BOX
	PILLAR
	MAJOR PIPELINE



 Scottish and Southern Energy plc.

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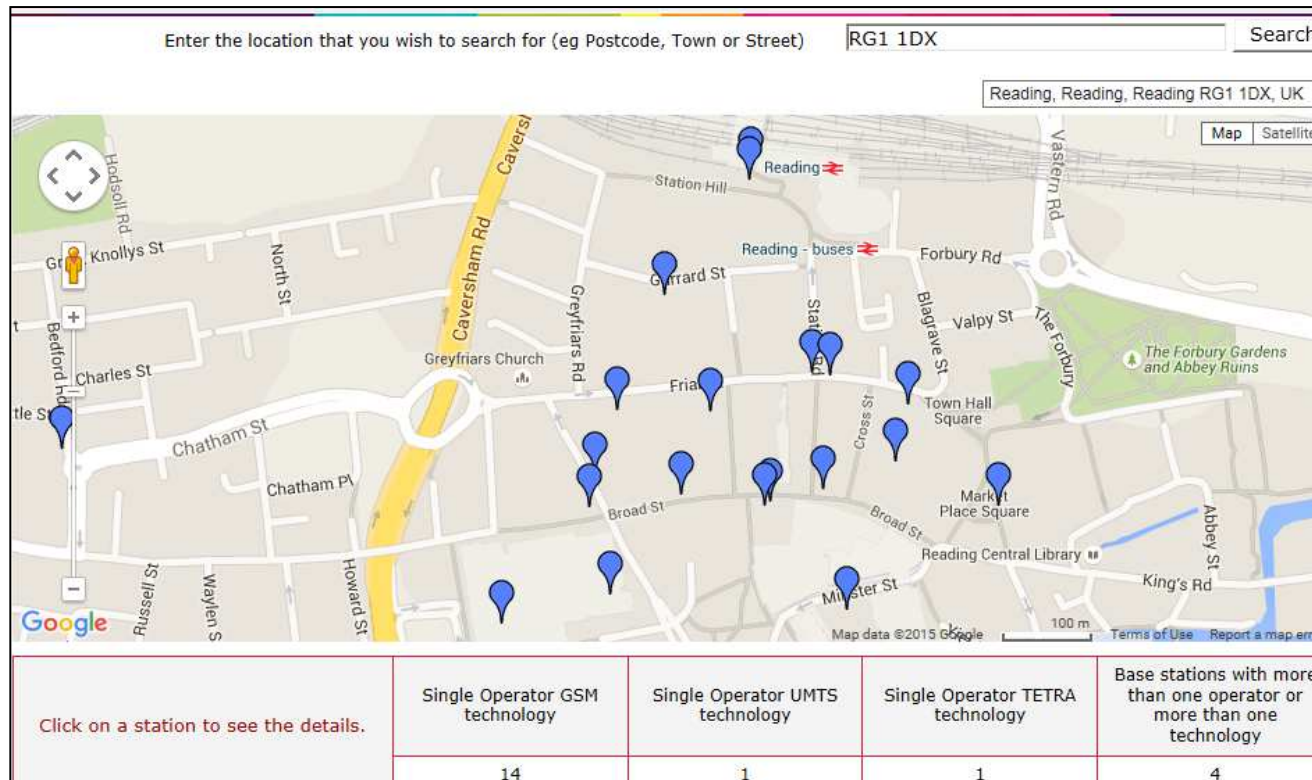
DATE: 14/06/2006		Subject to Revision Master held at
SCALE: 1:500		Mapping Services Unit 01256 337294
		INTERNAL USE ONLY

1.8 Ofcom



OFCOM mobile phone bases are located below:

For information on a particular site go to: <http://www.sitefinder.ofcom.org.uk/search>



OFCOM

Riverside House
2a Southwark
Bridge Road
London
SE1 9HA

Tel: 020 7981 3040

You may wish to contact the mobile phone operators directly. Links to their websites are provided below along with specific contact details for enquiries relating to mobile phone masts. If you are enquiring about a particular mast please quote the Operator Site Ref.

Airwave

Airwave Solutions Limited
Wellington Street
Slough
Berks
SL1 1YP

Telephone: +44 (0)8000 11 33 99

Fax: 020 7557 9000

Email: ServiceDesk.Receptionist@airwavesolutions.co.uk

Web: <http://www.airwavesolutions.co.uk/>

T-Mobile

Hatfield Business Park
Hatfield
Hertfordshire
AL10 9BW

Tel: 0870 321 6047

Fax: 01707 319022

Email: networkinfo@t-mobile.co.uk

Web: <http://www.t-mobile.co.uk>

Orange

Orange Personal Communication Services Ltd
St James Court
Great Park Road
Almondsbury
Bristol
BS32 4QJ

Telephone: 0870 376
Fax: 0870 376 4770

Email: Site.Information@everythingeverywhere.com

Web: <http://www.orange.co.uk/>

O2 UK

Telefonica O2 Europe plc
Network Consultation Help Desk
1 Brunel Way
Slough
Berkshire
SL1 1XL

Telephone: 01753 564 306

Fax: 08715 289 235

Email: networkconsultation@o2.com

Web: <http://www.o2.com/>

Network Rail

Community Relations
Network Rail
40 Melton Rail
London
NW1 2EE

Telephone: 08457 11 41 41

Fax: 020 7557 9000

Email: RailwayCommunicationsSystem@networkrail.co.uk

Web: <http://www.networkrail.co.uk/>

Vodafone

EMF Advisory Unit
Vodafone Ltd
The Exchange
Building 1330
Arlington Business Park
Theale
RG7 4SA

Telephone: 01635 677706

Fax: 01635 234858

Email: emf.advisoryunit@vf.vodafone.co.uk

3

5 Hester House
Battersea
London
SW11 4AN

Telephone: 0800 9177354
Or 01628 765000

Email: DLCTO3rdLineTechnicalSupport@three.co.uk

Web: www.three.co.uk

OFCOM

Riverside House
2a Southwark
Bridge Road
London
SE1 9HA

Tel: 020 7981 3040

2.0 SUMMARY

No major diversions are anticipated as a result of the proposed development, but it has been noted that an existing electricity substation is present on the site and the relocation of this during the works will be negotiated with the supply authority.

Gas service records indicate that a service exists to the north of the site but the route is not confirmed and this will require further investigation.

Many services (telecom, gas, electric, water, sewer, etc.) exist in the roadway and pathways surrounding the site.