PARSONS BRINCKERHOFF

November 2015

# NEW CROSS HEAT NETWORK: DESIGN STUDY

*LB Lewisham*

3514033A-BEL

***Final***

# New Cross Heat Network: Design study

**3514033A-BEL**

**Prepared for**
LB Lewisham

**Prepared by**
Parsons Brinckerhoff

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CONTENTS

## ABBREVIATIONS

| | |
|---|---|
| °C | degrees celsius |
| CHP | Combined Heat and Power (engine) |
| DECC | Department of Energy Climate Change |
| DE | Decentralised Energy |
| DHW | Domestic Hot Water |
| DH | District Heating |
| EHV | Extra High Voltage |
| EfW | Energy from Waste |
| GW | Gigawatts |
| GWh | Gigawatt-hour |
| GPR | Ground Penetrating Radar |
| HIU | Heat Interface Unit |
| HV | High Voltage |
| IP | Intermediate Pressure |
| kW | Kilowatts |
| kWh | Kilowatt-hour |
| LP | Low Pressure |
| LV | Low Voltage |
| LBL | London Borough of Lewisham |
| m | metres |
| m/s | metres per second |
| mm | millimetres |
| MPa | Megapascals |
| MW | Megawatts |
| MWh | Megawatt-hour |
| NDT | Non-Destructive Testing |
| SGN | Southern Gas Networks |
| SCR | Surrey Canal Road |
| SELCHP | South East London Combined Heat and Power |
| SH | Space Heating |
| TfL | Transport for London |
| WRC | Landmann Way Waste Reception Centre |
| WSP \| PB | WSP \| Parsons Brinckerhoff |

## EXECUTIVE SUMMARY

| | |
|---|---|
| This sheet is intended as a summary only | |

Key high level information determined in this study is presented below.

**Pipe size options:**

| Section | Length (m) | Pipe sizes (mm) | | |
|---|---|---|---|---|
| | | Base load system | Peak load system | Future-proofed |
| SELCHP to Sanford St | 699 | 100 | 125 | 350 |
| Sanford St to Childeric Primary | 967 | 100 | 125 | 200 |
| Childeric Primary to Batavia Rd | 82 | 100 | 125 | 200 |
| Batavia Rd to Goodw ood Rd | 270 | 80 | 125 | 200 |
| Goodw ood Rd to Goldsmiths | 343 | 80 | 100 | 150 |

**Expansion and stress reduction**

We have assumed that the system will be designed to a maximum axial stress of 190MPa. This is a safe limit for design under all conditions included in the guidance published by the biggest DH pipe manufacturer in the industry – Logstor. Note that the construction designers could consider a higher axial stress solution under consideration of the local and global stability of the pipe system; however we feel that, due to the likelihood of excavation around the DH pipe for maintenance of other services, a conservative approach to static design should be adopted. On this basis, our analysis shows that expansion loops are required at the following places:

- **Junction of Trundley's Road and Sanford Street**: to protect the 45° bend as the pipe diverts off down Sanford Street;
- **Sanford Street**: if designing to a maximum axial stress of 190MPa. It may be possible to accept a higher axial stress. The final network designer should consult with the DH contractor (if they are not the same) and evaluate based on result of site investigations;
- **Goodwood Road**: Z-bend at junction of Goodwood Road and New Cross Road to limit stress within the pipe section passing under Goodwood Road.

Stress reduction may also be required on Batavia Road if the pipe is installed deeper than 600mm.

**Project class**

Due to the size of pipes leaving SELCHP, the complexity of the design and the probability of excavation around the DH pipes for e.g. maintenance of other services, we propose that this project should be designed as a Type C project under *BS EN 13941*.

**Sites of engineering difficulty**

We propose the following areas as sites of engineering difficulty:

- **Junction of Surrey Canal Road and Trundley's Road**: due to the requirement to cross a very busy intersection and the significant gas infrastructure in this area;
- **Junction of Trundley's Road and Sanford Street**: due to the requirement to use a 45° bend and the subsequent requirement for stress reduction;

- **New Cross Road**: due to the requirement to install within a TfL red route containing significant other major services and subject to very high traffic flows and working restrictions.

**Section 50 applications**

LBL Highways advise that a separate Section 50 license is required for every street in which works are taking place. They did note that in some cases, works in multiple streets can be amalgamated under one Section 50 license if they are taking place in a single project. Although that would be the case for the New Cross Heat Network, we have conservatively assumed that each street would need its own Section 50 license.

| Section 50 license required |
|---|
| Landmann Way |
| Surrey Canal Road at Trundley's Road |
| Trundley's Road |
| Sanford Street |
| Clifton Rise |
| Batavia Road |
| Goodwood Road |
| St James's |
| Laurie Grove |
| Dixon Road |

**Enabling works**

A list of proposed enabling works is presented below.

- **Site investigations**: An extensive programme of trial holing and GPR is required to determine the exact pipe position and depth along the proposed route. Certain sections of the route require more comprehensive assessment, as detailed in the report.

- **LB Lewisham**: Section 50 Licenses for installation of apparatus;

- **SELCHP**: Wayleave may be required for installation within the facility. This is dependent on the ownership status of the apparatus. If Veolia/SELCHP install the apparatus, a Wayleave would not be required;

- **British Wharf Industrial Estate**: Wayleave required for installation in their land on Surrey Canal Road;

- **TfL**: Consent for working underneath London Overground rail bridges at Surrey Canal Road and Sanford Street;

- **TFL**: Permission required for installation of apparatus in New Cross Road.

**Site compound and welfare facilities**

The proposed position for a site compound and welfare facilities is Fordham Park. Pipe should be taken to the required positon on site on a daily basis using a road going pipe truck. Security measures are likely to be required at the site compound outside of working hours.

**Other items**

The following are also provided in the report:

1) Construction risk register;
2) Section analysis and methodology
3) Pipe network interface register
4) Trench dimensions for different pipe sizes
5) Typical trench sections
6) Future connections specification

SECTION 1

# INTRODUCTION

# 1 INTRODUCTION

## 1.1 Background

1.1.1 WSP | Parsons Brinckerhoff was appointed by the London Borough of Lewisham (LBL hereafter) to undertake a feasibility study for a heat network supplying Goldsmiths, University of London (Goldsmiths hereafter) with heat from the SELCHP waste incineration plant. The wider assessment consists of four elements:

**Element A**: A *route optimisation* study to determine the most effective route between SELCHP and Goldsmith's College;

**Element B**: A *network expansion* assessment to identify opportunities to establish additional connections to the network;

**Element C**: A *design* study to identify the technical requirements of the heat network, allowing likely costs to be calculated;

**Element D**: A *governance and delivery options* study for the heat network.

1.1.2 This report represents the output for *Element C*. *Elements A* and *B* have already been issued and *Element D* will be delivered in a separate report.

## 1.2 Report structure

1.2.1 This report progresses the design of the preferred route between SELCHP and Goldsmiths identified in the *Element A* report. Pipe sizes have been calculated for the *Element D* report and have been used to inform routing and static design calculations included in this report.

1.2.2 Pipes have been sized for the expanded network identified in the *Element B* report and include options for both peak and base load supply. They have also been future-proofed for additional unknown load.

1.2.3 The report assesses key design elements, including the interfaces at Goldsmiths, pipe stress and expansion, and sites of engineering difficulty. A future connection specification is included for pre-existing buildings and new build heat customers; and a section by section analysis and pipe interface register summarise the key logistical considerations for each section of the proposed route. A construction risk register is also included.

SECTION 2

# DESIGN

# 2 DESIGN

## 2.1 Network length

2.1.1 The as-installed network length will differ from the design network length as there will undoubtedly be small variations arising from conditions once the ground is excavated.

2.1.2 Section 5.3 recommends a programme of ground penetrating radar and trial holes to establish the exact position of existing services in key areas of the network. Once this work has been undertaken, for-construction design can be completed, allowing a more accurate assessment of network length to be undertaken.

2.1.3 In the absence of site investigation data, we have measured the network length based on the preferred route, as discussed in the section analysis presented in Section 4; and on the design for sites of engineering difficulty presented in Section 6.

2.1.4 The preferred network, as proposed, is **2,361 metres** in length.

## 2.2 Typical route sections

2.2.1 Trench cross sections will vary across the network according to the size of the pipe and the position and size of existing services. A summary of typical trench dimensions for different pipe sizes is presented in Table 2-1.

**Table 2-1: Typical trench dimensions for different pipe diameters**

| Pipe diameter (mm) | Trench width (mm) | Trench depth (mm) |
|---|---|---|
| 40 | 600 | 1025 |
| 50 | 630 | 1040 |
| 65 | 670 | 1060 |
| 80 | 710 | 1080 |
| 100 | 800 | 1125 |
| 125 | 950 | 1150 |
| 150 | 1010 | 1180 |
| 200 | 1160 | 1255 |
| 250 | 1350 | 1350 |
| 300 | 1450 | 1400 |
| 350 | 1490 | 1420 |

*NB: Assumes pipe insulation Series 2; cover to crown of pipe = 800mm*

2.2.2 Trench cross sections for 40mm and 350mm pipe are presented by way of example in Figure 2-1 and Figure 2-2.

**Figure 2-1: 350mm pipe indicative trench section**

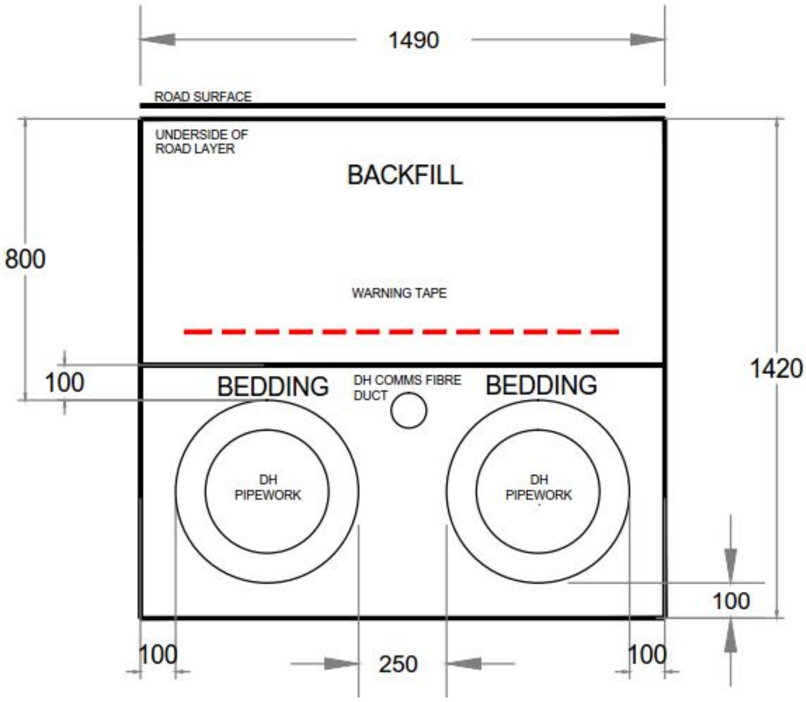
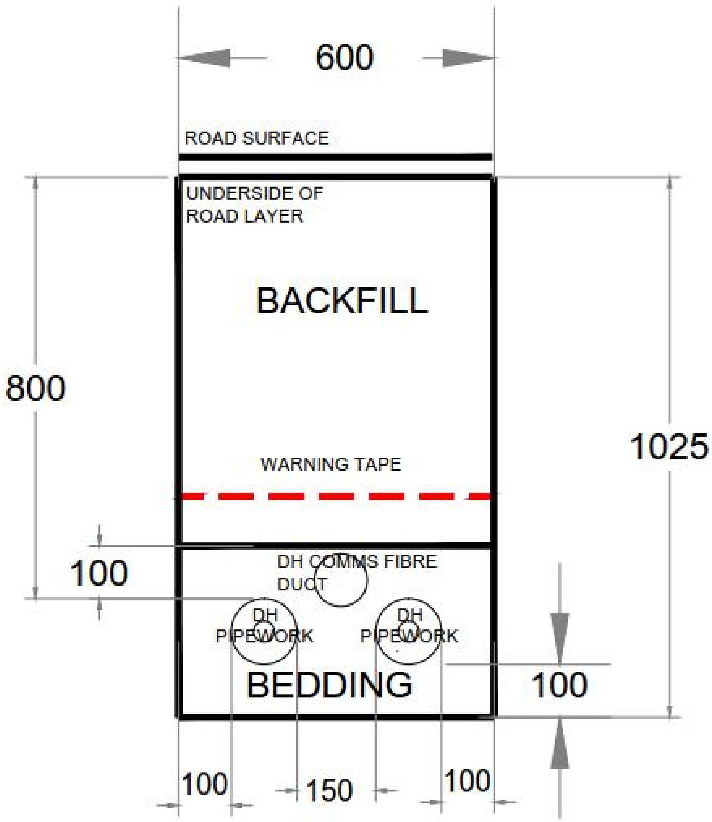



**Figure 2-2: 40mm pipe indicative trench section**



## 2.3 Goldsmiths interface – Education Building

2.3.1 Goldsmiths' ambition is that all of the heat load on their campus DH networks will be served from either the new 1 St James' energy centre or the existing Education Building energy centre. As such, only two points of connection to the DH network will be required.

2.3.2 The Education Building is, at the time of writing, undergoing a boiler replacement programme that includes stripping out asbestos contaminated pipework. We visited the site prior to the boiler replacement programme and Goldsmiths subsequently provided schematic and layout drawings for the plant room (post-installation of new boilers). The schematic and layout drawings have been developed by AECOM and are included in Appendix A of this report.

2.3.3 AECOM's schematic (MEP_100) shows two 200mm blanked DH connections on the existing boiler return pipework and also one on each of the new flow and return headers that are being installed as part of the boiler replacement programme. There are, therefore, two options for connecting a DH substation to the existing Education Building system. It is noted that AECOM's layout drawing (MEP_101) does not show space for a heat interface / substation for the incoming DH network. Following consultation with Goldsmiths, they confirmed that space is being allowed for a heat interface in the Oil Store, which is adjacent to the Education Building plant room.

2.3.4 It should also be noted that the 200mm blanked connections that have been left are based on a supply from SELCHP of approximately 5.5MW (as stated on drawing MEP_100). The assumptions behind this sizing are not clear; however we believe that it is based on a future configuration of load distribution and buildings connected to the campus heat network at Goldsmiths. We have downloaded gas consumption data for the Education Building plant room for the period 2013 to 2015 and the peak half hourly gas consumption through this period was 467kWh. Note that this is not the instantaneous peak; rather the maximum consumption over a half hour period.

2.3.5 Goldsmiths have advised that their intention is for other buildings to be connected to an expanded campus heat network in the future and it is upon this basis that our load assessment has been undertaken. We have been advised by Goldsmiths as to which of their existing buildings will be connected to the campus heat network and, from the existing boiler gas consumption data, we have assessed the connected load associated with this future scenario. This assessment, which is detailed further in the *Element B* report and takes account of future changes in campus building stock, concludes that the maximum hourly heat load for buildings that will be connected to the DH network would be 2MW over an hour. This assessment is based on half hourly kWh demands, so the peak instantaneous load in the connected buildings will be higher; however it makes little sense to size the SELCHP connections to meet instantaneous peak demand when there are existing boilers with sufficient resilience to do that job (the new 1 St James' building will also have its own boiler plant).

2.3.6 Based on our assessment and the information provided by Goldsmiths with regard to their future intentions for internal heat networks, a 2MW supply from SELCHP would be enough to serve almost all of the connected heat load which, based on gas consumption data between 2012 and 2015, is in the region of 3.9GWh. The *Element D* report will assess the commercial viability of reducing the connection sizes to a baseload only supply. This should be considered, given the cost of installing DH infrastructure and the issues identified in the *Element A* report around the number of existing services along the proposed route.

2.3.7 It is not possible at this stage to determine the distribution of the future connected load across the two Goldsmiths interfaces (Education Building and 1 St James'). We have therefore assumed an equal split, thus requiring an interface of 1MW at each of the two substations. Possibly lower if a baseload supply is determined to be more economically advantageous in the *Element D* report.

2.3.8 Goldsmiths have also stated their intention to undertake measures in their building stock to lower return temperatures. Their existing systems are 82/71°C flow and return however; as stated in the *Element A* report, we have assumed that their return temperatures will come down to around 60°C, providing a primary return temperature to the DH network of 65°C.

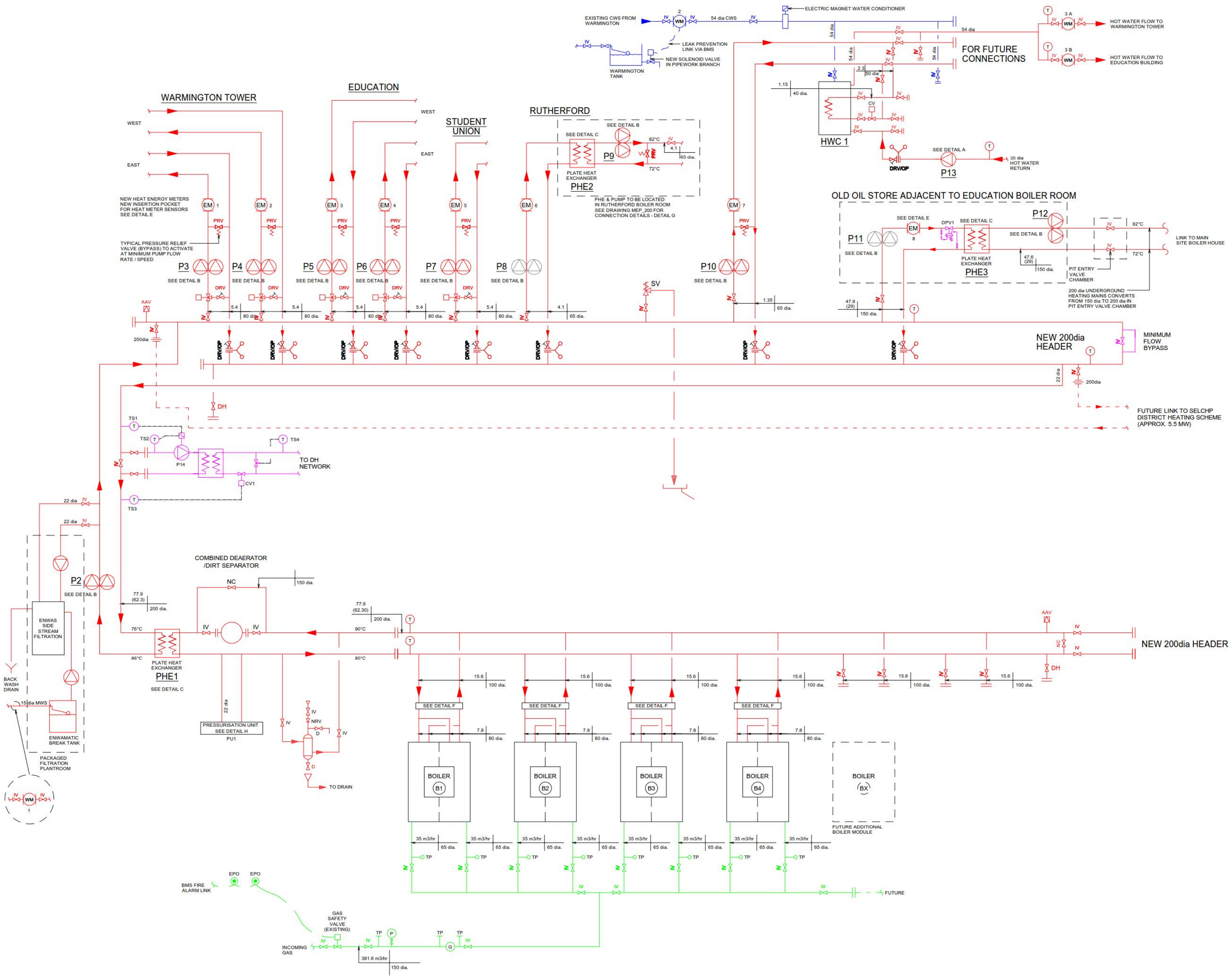
2.3.9 Based on the 2MW peak supply distributed across two substations of 1MW each; and a primary return temperature of 65°C (with a supply temperature from SELCHP of 110°C), we conclude that 80mm connections would be appropriate for each of the substations at 1 St James' and the Education Building. This is based on the temperature and load inputs just described and a maximum allowable pressure loss of 200 pascals per metre. Pressure loss and velocity limits are used to ensure the flow of water in the pipe does not cause excessive wear to the pipework and does not lead to excessive pumping energy requirements.

2.3.10 With regard to the positioning of the blanked connections in the Education Building, the two on the existing boiler return pipework are appropriate for supplying heat from SELCHP to the plant room. We have concluded that the DH connection will not be sized for peak instantaneous demand, so it is important to design the DH interface for conditions where the flow rate on the Goldsmiths circuit exceeds the flow rate across the DH heat exchanger. We have shown a high level interface design in Figure 2-3.

2.3.11 We have not seen the controls strategy for AECOM's design; however, based on the schematic, we note that it shows a pump on every secondary circuit coming off the new boiler header as well as a shunt pump (*P2*) onto the header. It is unclear what pump *P2* controls to; however it may be possible to remove the pumps on the two non-weather compensated circuits (pump *P8* for the Rutherford Building; and pump *P11* for the link to the main site boiler house) and allow pump *P2* to control to a differential pressure across *DPV1*[1] on *PHE3* in the old oil store. A minimum flow bypass would also be required to limit the flow around the new 200mm headers when the pump is at reduced output. These potential modifications are shown on Figure 2-3.

[1] *DPV1* is not currently installed. It would be necessary to install it in order to control the pump *P2* on differential pressure.

**Figure 2-3: Education Building DH interface and possible secondary system modifications (adapted from AECOM drawing 60312517-MEP-100)**



2.3.12 The DH substation would then controls as follows:

- *P14* controls to maintain a zero delta T (plus margin) at *TS2 minus TS1*;
- *CV1* controls to maintain specified flow temperature at *TS3* – nominally 82°C.

## 2.4 Goldsmiths interface – 1 St James'

2.4.1 1 St James' is part of the future campus development proposals for Goldsmiths. As such, it has not been constructed and therefore the interface with the New Cross Heat Network can be included as part of the M&E proposals for the energy centre that will be located within it.

2.4.2 The timeline for construction of 1 St James' is 2015 to 2018, as detailed in the Goldsmiths Master Plan (John McAslan & Partners, 2014).

2.4.3 Given that there are not yet any proposals for the design of the energy centre, it is proposed that the M&E designers for the project follow the guidance set out in the *New Connection Specification* referred to in Section 3 and presented in Appendix B.

## 2.5 Pipe sizing

2.5.1 It is important to note that there are implications if DH pipe is oversized. Low flow rates in large diameter pipes can lead to significant heat losses as the system water spends a long time in transit between the heat source (SELCHP) and the customer. This is particularly an issue in the summer months, when heat load is low. Minimum flow rates can be achieved with a bypass arrangement at the furthest load (Goldsmiths); however this would mean increased pumping energy to maintain a suitable flow rate.

2.5.2 Similarly, under-sizing of the pipework means increased frictional losses and therefore greater pumping energy requirement. It is important, therefore, that the detailed system design ensures adequate capacity in the pipe for the required load conditions without unnecessarily reducing the efficiency of the connection to Goldsmiths.

2.5.3 A balance must be struck between ensuring sufficient capacity within the pipe for future load scenarios, and optimising the operational performance of the scheme with regard to pumping energy and heat losses. We therefore recommend that pipe sizing is revisited as the scheme is further defined with regard to loads other than Goldsmiths that may connect in the future. The following is taken from the CIBSE/ADE *UK Heat Networks Code of Practice*:

*In both new build and retrofit schemes there are significant uncertainties in how the heat demands may develop over time and there will be a need to make a judgement regarding the potential for expansion. In practice some oversizing is not a major economic penalty as the pumping energy will be lower. Similarly, within the pressure constraints of the system, it will be possible to supply more heat than the original design through the same network by increasing pump pressures and operating* *energy. This means that most networks if conservatively designed will have considerable flexibility in the heat demands that can be economically supplied.*

2.5.4 For the purposes of this analysis, LBL requested that we evaluate the pipe sizing on the basis of Goldsmiths supply with the addition of a number of loads adjacent to the pipework linking Goldsmiths and SELCHP. They are:

- Childeric Primary school
- Batavia Road
- Goodwood Road
- Bond House

2.5.5 It has previously been stated that two heat supply options will be assessed economic viability:

1) **Peak load supply**: SELCHP meets peak demand at Goldsmiths and additional loads identified above. Back-up boilers are located at each customer site for when heat from SELCHP is unavailable;

2) **Base load supply**: Pipes are sized to meet base load demand at Goldsmiths and the loads identified above. Back-up boilers are located at each customer site for when demand rises above the base load connection or heat from SELCHP is unavailable.

2.5.6 Pipes sized for the two scenarios above would not be sufficient to supply the other loads identified in the *Element B* study, e.g. Convoys Wharf and Surrey Canal Triangle.

2.5.7 A third pipe sizing scenario has therefore been assessed, wherein the pipes are sized for a **future-proofed** network, serving not only the loads in the peak and base load scenarios identified above, but the whole preferred expanded network identified in the *Element B* study, as follows:

**Table 2-2: Expanded network loads**

| Name | Type |
|---|---|
| Goldsmiths - 1 St James' | Existing |
| Goldsmiths - Education Building | Existing |
| Batavia Road | New development |
| Surrey Canal Triangle | Future development |
| Convoys Wharf | Future development |
| Goodwood Road | Future development |
| Bond House | Future development |
| Achilles Street | Council housing |
| Arklow Road | Future development |
| The Wharves Deptford | Future development |
| Grinstead Road/Neptune's Wharf | Future development |
| Childeric Primary School | Existing |
| Deptford Green School | Existing |

2.5.8 It is noted that the design specification included in the ITT documentation states that pipes should be at specified diameters at key points along the network, as follows:

- SELCHP to the junction of Surrey Canal Road and Trundley's Road – 350mm.
- Junction of Trundley's Road and Sanford Street – 200mm

2.5.9 We have undertaken our own assessment of pipe sizing for the preferred expanded network option and can confirm that the sizes put forward in the ITT document are appropriate for the expanded network identified in *Element B* **with some additional future proofing**.

2.5.10 The pipe sizes required for each of the scenarios described above – base load; peak load and future-proofed – are presented below.

**Table 2-3: Pipe sizes: base load, peak load and future-roofed networks**

| Section | Length (m) | Pipe sizes (mm) | | |
|---|---|---|---|---|
| | | Base load system | Peak load system | Future-proofed |
| SELCHP to Sanford St | 699 | 100 | 125 | 350 |
| Sanford St to Childeric Primary | 967 | 100 | 125 | 200 |
| Childeric Primary to Batavia Rd | 82 | 100 | 125 | 200 |
| Batavia Rd to Goodwood Rd | 270 | 80 | 125 | 200 |
| Goodwood Rd to Goldsmiths | 343 | 80 | 100 | 150 |

2.5.11 Note that pipe sizing for the future-proofed scenario should be revisited as the scheme's engagement with potential additional connections such as Convoys Wharf progresses and more is learned about the developments. Note the following from the CIBSE/ADE *UK Heat Networks Code of Practice*.

*For new buildings the heat demand estimates should be produced by the appointed building services designer although the Heat Network designer may have valuable advice to offer based on previous experience. It is vital that a consensus is reached at this stage to avoid the potential for significantly oversizing or undersizing the network.*

2.5.12 Furthermore, as the structuring of the network delivery is further defined (see *Element D* report), the scheme design should take account of the owner's intentions for the long-term expansion of the scheme. It may be that a private sector owner may not wish to expand the scheme in line with the expanded network identified in *Element B*. If this is the case, the pipe sizes should be re-evaluated to avoid long-term issues with efficiency, as described in Section 2.5.1.

## 2.6 Expansion and stress reduction

2.6.1 There are multiple factors that affect expansion and the requirement for stress reduction in a district heating pipe and it is important that a detailed design process, including full static calculations for expansion and stress analysis, precedes the project construction phase.

2.6.2 Based on the routing proposed in this feasibility study and the condition of the heat available from SELCHP, it is possible to undertake a preliminary assessment of the likely stress characteristics and expansion on the network.

2.6.3 Expansion in buried DH mains is limited by the friction force applied to the pipe from the soil above it. Limiting expansion in this way means the pipe is under axial stress as the soil prevents the free expansion of the pipe.

2.6.4 In calculating stress and expansion, the depth of soil cover, the length and diameter of the pipe section, the temperature of the water and the insulation thickness are the determining factors. Expansion is greatest on long sections of straight pipe, i.e. where there is the greatest distance between expansion ends.

2.6.5 In determining the requirement for stress reduction, there are multiple options. Where pipes are 300mm in diameter or below and the design temperature differential[2] does not exceed 130°C, the designer may choose not to use any stress reduction. This is acceptable under certain conditions, but can put the system at risk of buckling if excavation around the installed pipe (e.g. for maintenance of other nearby services) causes it to expand further as friction material (which limits expansion) is removed.

Another, more conservative approach is to design an L190 system. This is where axial stresses in the pipe are never allowed to exceed 190 MPa.

2.6.6 If the design requires stress reduction, there are three ways of achieving it.

[2] The design temperature differential is defined as the maximum flow temperature and the cold fill temperature (assuming there is no preheating of the pipe), i.e. before the water is heated for the first time. The cold fill temperature in the UK is typically take to be between 8°C and 10°C.

1) By adding bends to take up the expansion and therefore reduce the axial stress: Typically this is done with U-loops – also known as expansion loops. This approach is expensive and requires space for the U-loop to be installed. It also increases the frictional losses in the pipework;

2) Expansion compensators: These are fittings that take up the initial expansion within a pipe as the water is heated for the first time. Once the water is up to temperature, the expanded compensator is permanently secured and becomes part of the main pipe. The disadvantage to this approach is that it only works once;

3) Pre-stressing: This is where the pipe is pre-heated to take up some of the expansion before it is buried. This is expensive as it requires electricity to heat the pipe and also requires long sections of trench to be left open at any one time.

2.6.7 Given the number of existing utilities installed and the likelihood of excavation along the pipe route in busy London streets, the conservative approach at this stage would be to assess the expansion requirements with a maximum allowable axial stress of 190 MPa. A for-construction expansion assessment should be undertaken by the scheme's designers prior to installation.

2.6.8 We have assumed that Series 2 Logstor pipe will be installed. The pipe length at which Series 2 DH pipe reaches axial stress of 190 MPa for different pipe diameters at different installation depths is shown in Table 2-4[3].

**Table 2-4: LOGSTOR pipe lengths at axial stress of 190 MPa**

| Pipe diameter (mm) | Pipe length at 190 Mpa - variable installation depts | | | |
|---|---|---|---|---|
| | 600mm to crown of pipe | 800mm to crown of pipe | 1000mm to crown of pipe | 1500mm to crown of pipe |
| 25 | 80 | 62 | 50 | 34 |
| 32 | 90 | 68 | 56 | 38 |
| 40 | 104 | 78 | 64 | 42 |
| 50 | 128 | 98 | 80 | 54 |
| 65 | 142 | 108 | 88 | 60 |
| 80 | 146 | 112 | 90 | 60 |
| 100 | 186 | 142 | 116 | 78 |
| 125 | 202 | 156 | 126 | 86 |
| 150 | 238 | 184 | 150 | 102 |
| 200 | 268 | 208 | 170 | 118 |
| 250 | 284 | 222 | 182 | 126 |
| 300 | 332 | 262 | 216 | 150 |
| 350 | 346 | 274 | 226 | 158 |

[3] While these values may differ slightly for different manufacturers, there is very little different in the pipe construction and materials, so there would be little difference in their L190 lengths.

2.6.9 Note that the position at which axial stress reaches 190MPa in a straight pipe run is independent of temperature. The temperature differential affects the maximum axial stress level that could be reached in a pipe, for example if the temperature differential is 50°C, the maximum axial stress level that could be reached in any length of pipe is 125MPa.If the temperature differential was 100°C, the maximum axial stress level that could be reached in any length of pipe is 250MPa. The point at which these stress level are reached is a product of the pipe diameter and the force applied by the soil above only – not the temperature.

2.6.10 It can be seen from the L190 data table (Table 2-4) that the shallower the pipe is buried, the longer it can be before it reaches an axial stress of 190 MPa. As described earlier, the reason for this is because the soil applies a friction force to the pipe, restricting its free expansion and increasing the axial stress level. Therefore, although expansion increases when pipe is installed at shallower depth, axial stress is reduced.

Surrey Canal Road

2.6.11 The preferred route on Surrey Canal Road makes use of the British Wharf land adjacent to the cycle path and the landscaped area to the east of the rail bridge. This route has the added benefit of creating natural bends in the long section along Surrey Canal Road, as shown in Figure 2-4.

2.6.12 The maximum straight length along this section is 133 metres through the British Wharf land, as shown in Figure 2-4.

**Figure 2-4: Preferred route along Surrey Canal Road**

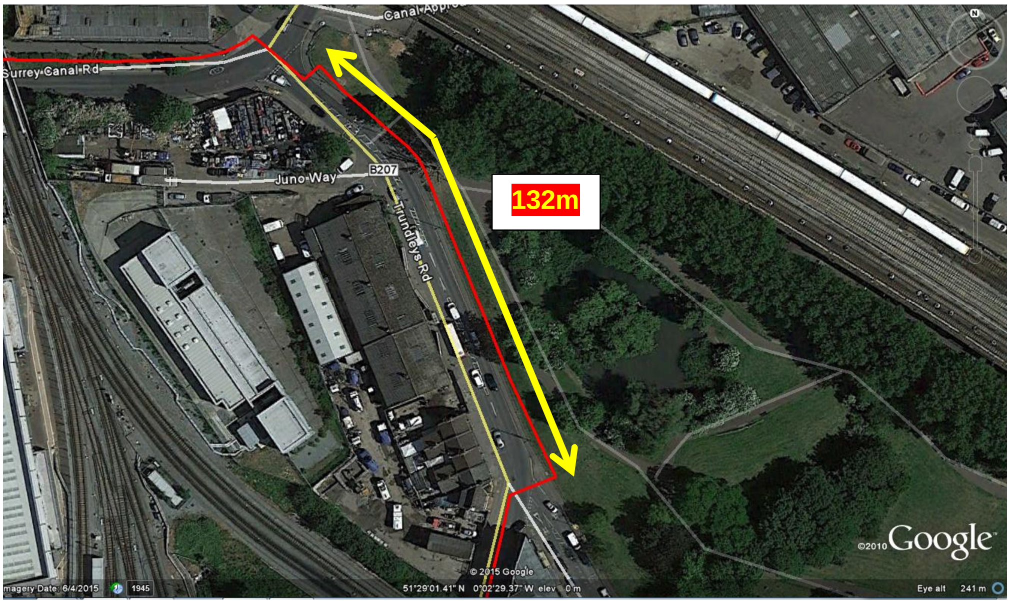

2.6.13 Pipe diameter on this section of the network should be 100mm for a base load network; 125mmmm for a peak supply network; or 350mm for a future-proofed network (see Table 2-3).

2.6.14 Referencing the maximum pipe lengths for 190MPa maximum axial stress in Table 2-4, it confirms that stress reduction measures would not be required on Surrey Canal Road unless the pipe is installed deeper than 800mm to the crown of the pipe. The proposed route is to install through the soft dig British Wharf land, so it is unlikely that the pipe would need to be installed deeper than 800mm.

<u>Trundley's Road</u>

2.6.15 The longest straight section on Trundley's Road, as show in Figure 2-5, is 132 metres. The pipe diameter in this section would be 100mm for a base load network; 125mmmm for a peak supply network; or 350mm for a future-proofed network (see Table 2-3).

**Figure 2-5: Route along Trundley's Road / Folkestone Gardens**




2.6.16 Referencing the L190MPa Table 2-4, we can conclude that stress reduction measures would not be required on Trundley's Road as long as the pipe is not buried deeper than 800mm to the crown of the pipe. The proposed route through this area is in Folkestone Gardens, with landscaping to re-profile the soft dig land at the edge of the park. As such, it will be possible to ensure pipe is not installed any deeper than 800mm.

<u>Sanford Street</u>

2.6.17 The longest straight section of pipe on the proposed network route is at Sanford Street. In calculating expansion and axial stress, curved pipe is treated the same as straight pipe. The distance between expansion ends on Sanford Street is the length of the road between Trundley's Road and Childeric Road, where the preferred route turns off into Fordham Park – approximately 650m.

**Figure 2-6: Pipe route down Sanford Street**


2.6.18 Pipe diameter on this section of the network should be 100mm for a base load system; 125mm for a peak load system; or 300mm for a future-proofed system. Due to the relative lack of other services in the carriageway along Sanford Street, we assume that pipe could be installed around 600mm deep.

2.6.19 Table 2-4 shows that DH pipes of 100mm, 125mm and 300mm, installed at 600mm depth reach axial stress of 190MPa when the pipe is 186m, 202m and 332m in length respectively. As such, stress reduction measures will be required along this section of network if it is designed to a maximum axial stress of 190MPa.

2.6.20 Given the relative lack of other services in Sanford Street – and the pipe size and temperature differential – it may be acceptable to install without any stress reduction and allow the system to operate at higher axial stress. However, it is noted that the junction of Trundley's Road and Sanford Street is likely to require a 45° bend (see Figure 2-5). Short angle bends are subject to high radial expansion and must therefore be protected by limiting the distance between the short angle bend and the next 90° bend. This is discussed in more detail in Section 6.2; however it is concluded that a U-loop will be required somewhere around the Trundley's Road end of Sanford Street in order to protect the 45° bend at the junction of Sanford Street and Trundley's Road.

<u>Batavia Road</u>

2.6.21 The preferred route extends approximately 177m down Batavia Road between Clifton Rise and Goodwood Road, as shown in Figure 2-7. The pipe diameter at this point is 80mm for a base load network; 125mm for a peak load network; and 200 for a future-proofed network.

Figure 2-7: Pipe route along Batavia Road


2.6.22 If the network is designed for a maximum axial stress of 190MPa, the pipe must be installed at 600mm or shallower to avoid the requirement for stress reduction for a 100mm pipe and 800mm or shallower for a 200mm pipe. An 80mm pipe would require stress reduction.

2.6.23 The Batavia Road development incorporates the carriageway and has been excavated and reinstated for the installation of new services into the development, including a local heat network served from a new plant room. The extent of the services in the carriageway is not currently known and it is not possible to determine the depth of installation without site investigation. It is proposed, however, that it may be possible to allow a higher axial stress than 190MPa as long as the stability of the DH pipework through Batavia Road is not compromised by the possibility of removal of backfill due to, for example, maintenance of other services. This should be assessed if it is determined that the pipe must be installed deeper than 600mm for a 100mm pipe and 800mm for a 150mm pipe.

## 2.7 Project class

2.7.1 *BS EN 13941* provides design guidance for DH networks and states that every DH project should be defined according to one of three project classes for pre-insulated steel DH pipework – A, B and C. The class applied to a project determines the requirements for, amongst other things, design methodology, safety factor application and extent of non-destructive weld testing (NDT).

2.7.2 Class C projects are the most onerous in terms of design requirement and are generally defined as projects with large diameter pipes (>300mm) with a design temperature differential of more than 130°C[4] .

2.7.3 Class B projects are generally projects involving pipe sizes up to and including 300mm and with a temperature differential of between 86°C and 130°C. Class A projects are for the same pipe size range as class B projects but with a temperature differential up to 85°C.

2.7.4 There are factors that mean a system could be defined as class C even if pipe sizes do not exceed 300mm and the temperature differential does not exceed 130°C. Examples of those conditions are:

- Where there is a likelihood of excavation along or across the pipe route. Soil applies a friction force to buried pipework, limiting the expansion. Where this soil is removed, the pipe is free to expand, increasing the risk of buckling in that section.

- Where the network design is very complex, e.g. involving small angle bends (<90°).

- Where there is very little soil cover – particularly in sections where there is curved pipe.

2.7.5 Heat supply from SELCHP would be at a maximum of 110°C, as confirmed by SELCHP. With a cold fill temperature of 10°C, the temperature differential on the network would not exceed 130°C.

2.7.6 Pipe sizes have been assessed in Section 2.5 of this report and it has been concluded that the diameter of the pipe outside SELCHP could exceed 300mm. It is also clear that there are sections of the network where there are a significant number of other services in the vicinity. As such, the probability of there being excavation around the pipework, once installed, is considered to be quite high. We therefore propose that this project should be considered a **Type C** project as per *BS EN 13941*.

[4] The temperature differential referred to here is the differential between the flow temperature and the cold fill temperature in the DH pipework.

SECTION 3

# FUTURE CONNECTION SPECIFICATION

# 3 FUTURE CONNECTION INTERFACE SPECIFICATION

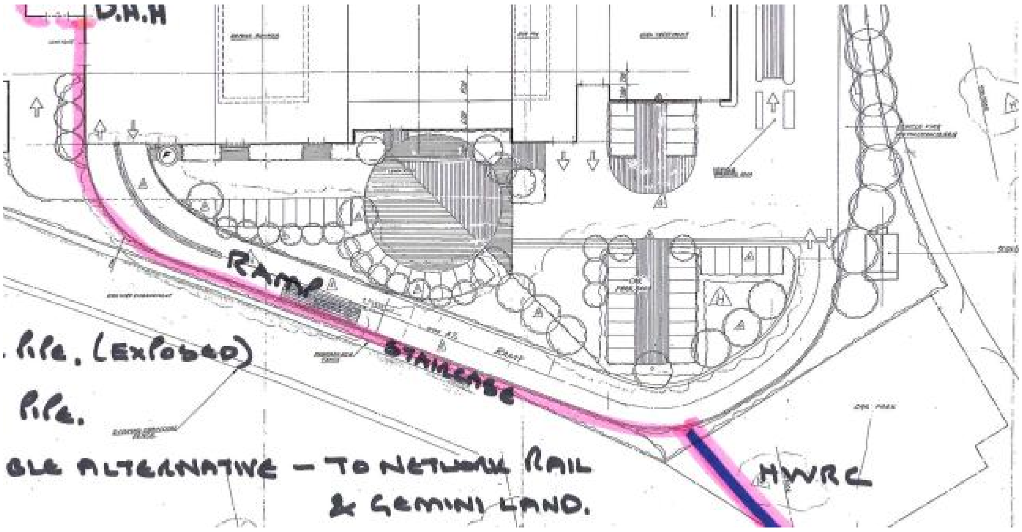
3.1.1 A future connection specification for both pre-existing and new build additions to the DH network is presented in Appendix B.

SECTION 4

# SECTION ANALYSIS AND INSTALLATION METHODOLOGY

# 4 SECTION ANALYSIS AND INSTALLATION METHODOLOGY

## 4.1 SELCHP




4.1.1 The pipe route within the SELCHP facility has been determined by Veolia and is as described in the *Element A* report and shown above. The pipe will be installed above ground within the facility boundary and will be supported from multiple structures, including the curved access ramp from which waste vehicles access the facility. This type of installation will require bespoke design and it is recommended that one of the pipe manufacturers is engaged to assist in this design process.

Overall length of section: 175m

Length of hard dig: 0m

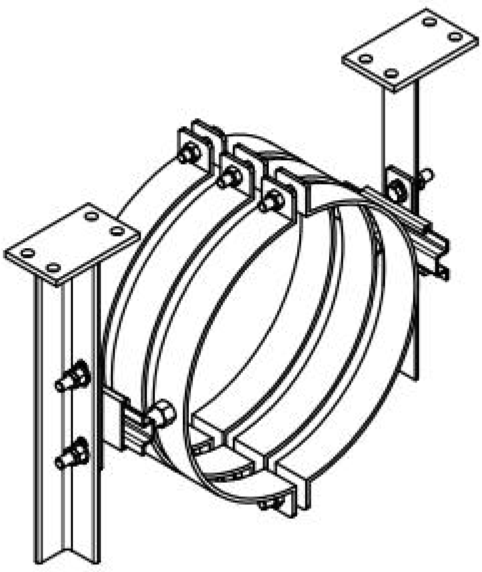
Length of soft dig: 0m

Length above ground: 175m

Key issues:

- Wayleave required for installation in SELCHP Ltd land, unless SELCHP own the pipework;
- Installation must not affect daily operations within the facility (access of trucks);
- Greater expansion due to installation above ground (not restrained by friction from soil);
- Bespoke design for bracketry supporting the pipe under the access ramp (see Figure 4-1);
- Consideration of anchoring and implications on supporting structures;
- Working at height as pipe is supported by structures at high level;
- Mechanical protection of the exposed pipework may be required.

Figure 4-1: Example of supporting bracket for DH pipe



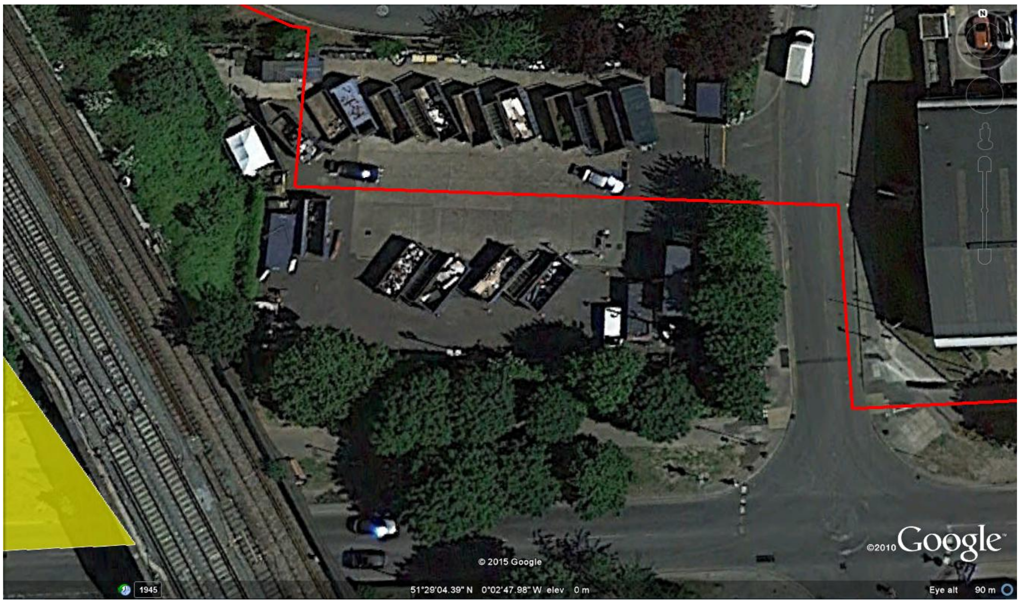
4.1.2 Proposed methodology:

- In discussion with Veolia, they advised that they would appoint a competent contractor to undertake the works within their site. As such, depending on the delivery structure, the contractor delivering the wider DH network may be required to interface at a demarcation point at the SELCHP boundary with the SELCHP appointed contractor;

- If required, a short shutdown period could be arranged for the existing DH network; however this would be a short period and would most likely be in the summer;

- Veolia would liaise with the contractor with regards storage and working conditions within their site.

## 4.2 Waste Reception Centre and Landmann Way




4.2.1 SELCHP's original proposal was for the pipe to be installed straight through the Landmann Way Waste Reception Centre (WRC). The *Element A* report identified that this approach would require installation through more of the new cycle route and would therefore be more expensive. It was confirmed with LBL waste and environment officers that the route could pass through the middle of the WRC and out onto Landmann Way as long as provision could be made for alternative waste disposal during the installation period. They also noted that the pipe installation should not affect the two ponds in the WRC.

Overall length of section: 95m

Length of hard dig: 95m

Length of soft dig: 0m

4.2.2 Key issues:

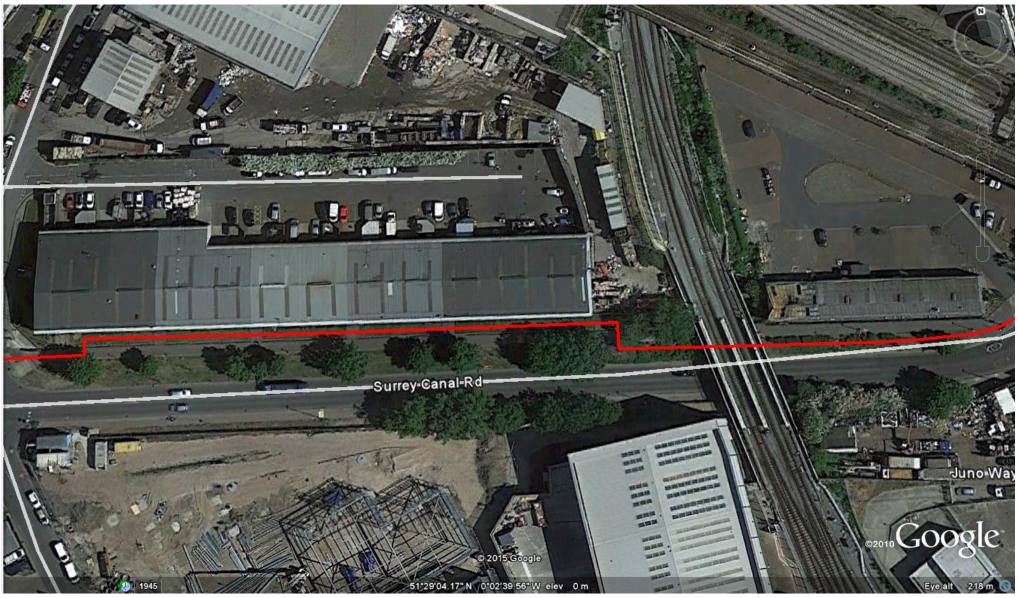
- Access for refuse vehicles using SELCHP must be maintained;
- Access to British Wharf industrial estate and other businesses on Landmann Way must be maintained;
- Temporary closing of WRC means alternative must be provided until it reopens;
- Ponds within WRC boundary to be unaffected by works;
- Pipe to cross line of existing services on Landmann Way.

4.2.3 Proposed methodology:

- Pre-tender for contractor, consult SELCHP with regard to scheduling of works and maintaining access to SELCHP during works;

- Liaise with British Wharf and other business owners to advise of works schedule and discuss provision for access;
- Advance notice signs for closure of WRC and works on Landmann Way. Allow sufficient lead time;
- Night-time working when crossing Landmann Way to minimise disruption;
- Use road plates over trenches as necessary to allow continued access to SELCHP during daytime.

## 4.3 Surrey Canal Road




4.3.1 Following the issue of the *Element A* report, a risk workshop was held with LBL departmental officers to discuss some of the issues around key sections of the proposed route. Two options had been identified as potentially viable for installation in Surrey Canal Road: installation in the south side footway; or installation in the British Wharf soft dig land, moving into the landscaped area between the cycle path and the carriageway. Of the two options, it was concluded that the south side footway would not be viable due to the impact on traffic flows from the working area, which would encroach onto the road. The soft dig land adjacent to the cycle path is therefore preferred on the basis that it minimises the impact on the carriageway, which is a major route through the area. This area requires a wayleave from British Wharf, who own the soft dig land. If this cannot be arranged, it may be necessary to install in the cycle path, although this should be avoided if at all possible.

4.3.2 Key information:

Overall length of section: 280m

Length of hard dig: 60m

Length of soft dig: 220m

4.3.3 Key issues:

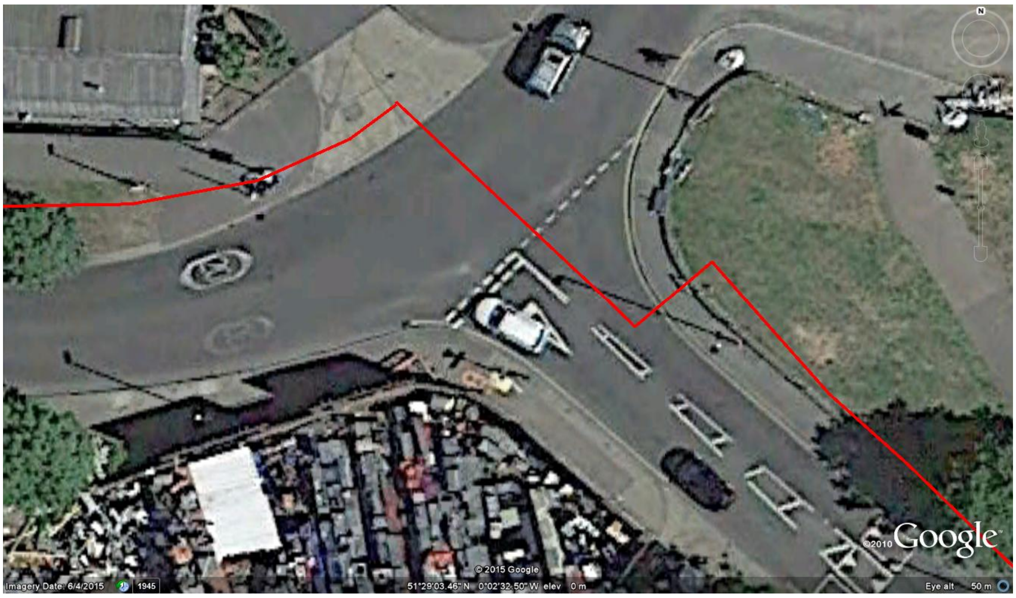
- It will be necessary to dig up a short section of cycle path before moving into British Wharf land. Multiple existing services including EHV electricity cable are present within the cycle path;
- Wayleave required for installation in British Wharf land;
- Consent required from TfL for works under rail bridge. They may also require an asset protection agreement;
- Working area will encroach onto the cycle path;
- Necessary to cross the cycle path to move into landscaped area under the bridge;
- Crossing cycle path will mean passing under multiple existing services. Hand dig only;
- Diversions required for cycle path closure. Notice required;
- Reinstatement of cycle path with bonded gravel to full width of path where excavated;
- Risk of material falling onto the road during excavation of landscaped area under rail bridge;
- Re-landscaping of area under rail bridge to be agreed with LBL.

4.3.4 Proposed methodology:

- Secure consent from TfL for working underneath the railway bridge (see *Element A Transport Infrastructure Impact Assessment report*);
- Advance notice signs indicating duration of works and cycle route diversion;
- GPR and trial hole as required along proposed route to identify services. Use the GPR to identify pinch points and position trial holes;
- Important to determine depth of existing services under cycle path at the point where the DH pipe will cross from British Wharf land into the landscaped area between the carriageway and the cycle path. This site investigation may have been done in advance as part of a detailed route proving exercise;
- Excavate along c. 15m of cycle path using mechanical and hand dig as required until pipe can turn 90° into British Wharf land;
- Mechanical soft dig trenching in British Wharf land;
- Cross cycle path at appropriate depth to pass underneath existing utilities and into landscaped area adjacent to carriageway;
- Shoring for landscaped area under rail bridge before excavating and installing pipework;

- Reinstate landscaping to agreed design;
- Continue to junction with Trundley's Road.

## 4.4 Junction of Surrey Canal Road and Trundley's Road




4.4.1 Based on the work that has been undertaken to date, the junction of Surrey Canal Road and Trundley's Road is considered to be the most challenging section of the network as a result of the existing services – gas mains in particular – that cross this intersection and the high daytime traffic flows. A proposal for the design of this section is presented in Section 6.1.

Overall length of section: 12m

Length of hard dig: 12m if a straight line across the road

Length of soft dig: 0m

4.4.2 Key issues:

- Significant gas infrastructure, including two 600mm intermediate pressure mains and a 250mm low pressure main;
- High traffic volumes during the daytime;

  New cycle path will cross Surrey Canal Road here to pass into Folkestone Gardens.

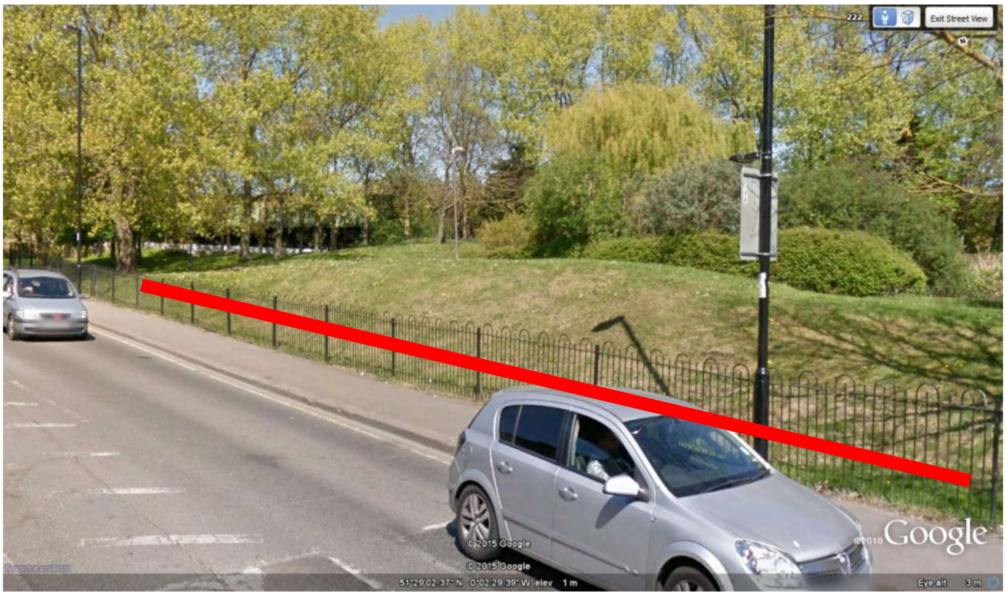
4.4.3 Proposed methodology:

- Engage Southern Gas Networks (SGN) early and share designs and working methods for comment;
- Advance road signs detailing working times, possible delays and traffic management;

- Inform Southern Gas Networks of working dates so that they can witness excavation in the vicinity of intermediate pressure mains;
- Undertake night time trial holing, with traffic management and/or diversions, to try and find a route through existing services. Consider working over two consecutive nights to maintain one way traffic flows. Works should seek to find a route across the junction and into Folkestone Gardens;
- Use night time working with traffic management and/or diversions to minimise disruption to traffic during installation;
- Road plates can be used to allow traffic flows through the day time;

  Depending on the installation depth, steel plates or a concrete raft may be required to protect the pipe from vertical loading due to traffic flows across Surrey Canal Road.

## 4.5 Trundley's Road / Folkestone Gardens




4.5.1 Following consultation with LBL officers, it was confirmed that the pipe can be installed along the edge of Folkestone Gardens, as shown in the image above. The pipe would be installed at, or close to, the existing ground level and the mound behind it re-profiled so that the pipe is buried.

Overall length of section: 160m

Length of hard dig: 40m

Length of soft dig: 120m

4.5.2 Issues:

- Access for businesses on Trundley's Road must be maintained;

- Getting from the junction of Trundley's Road and Surrey Canal Road into Folkestone Gardens (significant gas infrastructure in the area);
- Agree landscaping design with LBL Parks officers.
- Pipe must cross Trundley's Road to divert down Sanford Street.

4.5.3 Proposed methodology:

- Liaise with Trundley's Road business owners to advise of works schedule and discuss provision for access;
- Advance notice signs detailing work dates in Folkestone Gardens;
- Advance notice signs for works in junction of Trundley's Road and Sanford Street;
- Inform Southern Gas Networks of working dates so that they can witness excavation in the vicinity of intermediate pressure main in Folkestone Gardens and Trundley's Road;
- Trial holes to determine route through existing services from junction of Surrey Canal Road and Trundley's Road into Folkestone Gardens (see Section 6.1);
- Hard dig – mechanical and hand dig as required – to install from junction of Surrey Canal Road and Trundley's Road into Folkestone Gardens;
- Soft dig / installation along outer edge of Folkestone Gardens. Reinstate to landscaping design agreed with LBL Parks officers;
- Hard dig across Trundley's Road towards Sanford Street. Cross the line of intermediate pressure gas main, which appears to be at c. 2m depth to crown (based on SGN drawing).

## 4.6 Sanford Street


4.6.1 Sanford Street has been selected as an alternative to Woodpecker Road due to the number of services in Woodpecker Road and the relative width and lack of services in Sanford Street. Although it is a carriageway, the utilities mapping shows relatively few existing services, most of which appear to be in the footway and grass verge. The wide carriageway means traffic flows could be maintained with appropriate traffic management.

Overall length of section: 650m

Length of hard dig: 650m

Length of soft dig: 0m

4.6.2 Key issues:

- Long straight section means expansion loop may be required (see Section 2.5.1);
- Consent required from TfL for works under rail bridge: They may also require an asset protection agreement;
- Traffic management required due to working in carriageway.

4.6.3 Proposed methodology:

- Secure consent from TfL for working underneath the railway bridge (see *Element A Transport Infrastructure Impact Assessment report*);
- Advance notice signs for works in carriageway;
- Hard dig – mechanical excavation through northbound carriageway and install pipe;

- Trench excavation, pipe installation and backfill/reinstatement to be undertaken sequentially through sections of carriageway;
- Traffic management to follow sections as described above;
- See Section 2.5.1 and Section 6.2 for discussion around requirement for, and position of, expansion loops.

## 4.7 Fordham Park


LBL Parks officers have previously expressed a preference for the pipe to be installed in Childeric Road, rather than going through Fordham Park. Following a risk workshop with LBL officers, including Parks officers, it was agreed that it would be difficult to install in Childeric Road for several reasons: the road is narrow and contains multiple existing services; it is a controlled parking zone; and it is a residential street. It was therefore agreed that Fordham Park would be preferable as long as reinstatement of the footpaths was like-for-like replacement of bonded gravel for the full width of the path.

It is noted that much of Fordham Park is soft dig and it should therefore be possible to avoid excavating the footpaths for the majority of the installation through the park, as shown in the above picture. This would also reduce the cost of installation significantly.

Overall length of section: 250m

Length of hard dig: 85m

Length of soft dig: 165m

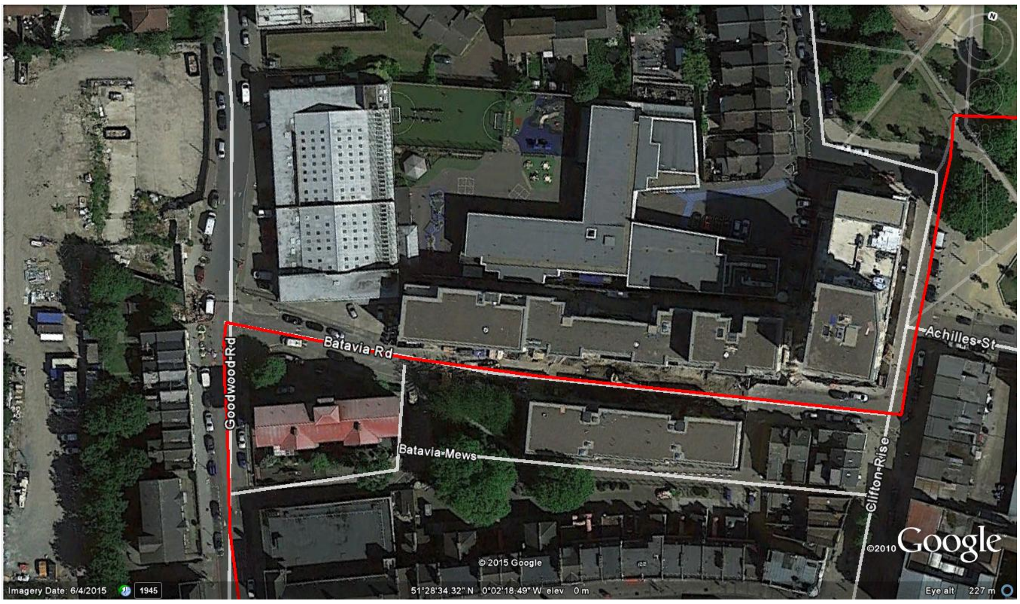
4.7.1 Key issues:

- Ensure any excavated footpath is reinstated with bonded gravel to the full width of the path;
- Ensure any excavated soft dig area is reinstated as agreed with LBL Parks officers;
- Impact on people using the park.

4.7.2 Proposed methodology

- Advance notice signs detailing work dates in Fordham Park;
- Where excavation is taking place in, or adjacent to, a footpath, close the footpath altogether in the interests of public safety;
- Route through park from junction of Childeric Road and Sanford Street in the north-west corner through to Clifton Rise in south-west corner, as shown in preceding image.

## 4.8 Clifton Rise / Batavia Road / Goodwood Road




4.8.1 Batavia Road is currently undergoing construction as part of the Batavia Road development project and the road is closed; however the development is scheduled for completion in September of this year (2015). The road surface on both Clifton Rise and Batavia Road is road bricks, so it will be necessary to reinstate to this standard upon installing the DH pipework. Goodwood Road is a tarmac finish.

Overall length of section: 325m

Length of hard dig: 325m

Length of soft dig: 0m

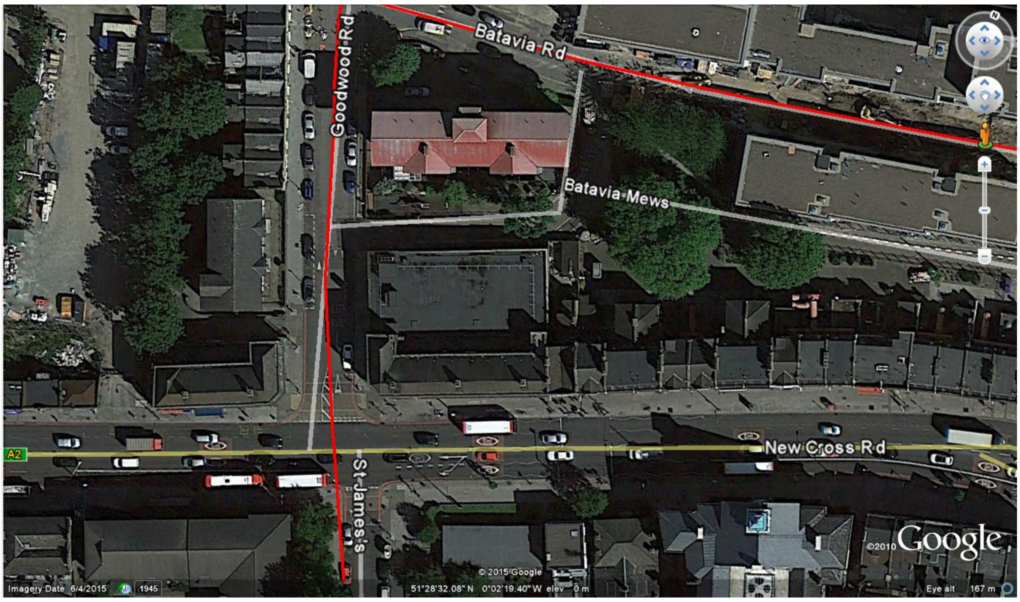
4.8.2 Key issues:

- Reinstatement of road bricks on Clifton Rise and Batavia Road;
- Impact on businesses on Clifton Rise and residents on Goodwood Road;
- Proximity of residential property – potential noise issue.

4.8.3 Proposed methodology

- Advance warning signs notifying of dates for works;
- Liaison with Choice Cars taxi rank on the corner of Clifton Rise and Batavia Road to ensure they are aware of the works, which will have a potential impact on their taxis;
- Road closure on Clifton Rise from the junction with Batavia Road, north towards Fordham Park;
- Sequential excavation, installation and reinstatement along the proposed route;
- Ensure road bricks are lifted without damaging where possible, retained and reused upon reinstatement;
- Reopen Clifton Rise as soon as installation is complete in this section.

## 4.9 New Cross Road




4.9.1 New Cross Road is a TfL road and, as such, permission to install infrastructure in the road must be sought from TfL. In the *Element A* report, we summarised discussions with TfL, in which they confirmed their requirements for allowing works to proceed on red routes. The point at which the DH route crosses New Cross Road was moved following the *Element A* investigation due to difficulties in crossing at the originally proposed location – namely a central trief kerb that would make maintaining two-way traffic flows more difficult; and the position of Goldsmiths connection points on the other side of New Cross Road.

Overall length of section: 12m

Length of hard dig: 12m

Length of soft dig: 0m

4.9.2 Key issues:

- Two-way traffic flows to be maintained at all times;
- Night working required to minimise duration of works in the road;
- Multiple services cross the line of the DH pipe, although most of them appear to be in the footpaths rather than the carriageway;
- Lane rental fees apply for working within specified hours (as detailed in *Element A* report).

4.9.3 Proposed methodology

- Liaison with TfL to agree TM and installation methodologies and timing of works;
- Advance warning signs notifying of dates for works;
- Undertake pre-installation GPR (see Section 5.3.) to confirm extent of services in the carriageway. If necessary, undertake pre-installation trial holing in carriageway (sequentially, maintaining two way traffic flows). Trial holes will be required in the footways on either side of the crossing to establish the depth of services;
- Number of welds / pipe sections increased to enable sequential crossing of the road whilst maintaining two-way traffic flows;
- During installation, use of road plates to maintain traffic flows as necessary.

## 4.10 St James's Road / Goldsmiths campus


4.10.1 Once across New Cross Road, the route runs south down St James's, where the new Goldsmiths building (1 St James) will be constructed, before turning off into the campus. It runs through the Laurie Grove baths site and out onto Laurie Grove, before passing through a short alley into the courtyard outside the Education Building. It was noted in the *Element A* report that it might not be feasible to use the alley as it appears to have a number of services already running through it. Goldsmiths advise that these services are their own internal communications cables so, if necessary, diversions could be arranged. An alternative would be for the pipe to continue up Laurie Grove, branching off down Dixon Road and into the Education Building that way (as shown on the image above). Goldsmiths advise that this is a strategically important road, so working in the road should be minimised. As such, diverting comms services in the alley should be pursued if necessary.

Overall length of section: 240m

Length of hard dig: 240m

Length of soft dig: 0m

4.10.2 Key issues:

- Disruption to campus and housing on Laurie Grove;
- Potential constraints in narrow areas, i.e. Laurie Grove Baths and the alley between Laurie Grove and the Education Building;
- Changeover onto DH network may require a shutdown of parts of the campus heat supply.

4.10.3 Proposed methodology

- Liaison with Goldsmiths to agree programme and working requirements on campus;

- Trial holing at pinch points, i.e. alley between Laurie Grove and the Education Building; and the route through Laurie Grove Baths.

- Trenching and installation of pipework using hard dig techniques along the route identified through trial holing process.

- Substations to be installed without disruption to Goldsmiths' heating systems. Final changeover to DH integration over weekend to minimise down time.

### 4.11 Site compound and storage

4.11.1 It is important that the appointed contractor is given adequate space for the provision of welfare facilities and the storage of materials for the duration of the project. Given the extent of the network, it is likely that storage would ideally be located in different places as the works progress along the route.

4.11.2 There are areas of the proposed route that are sensitive to the impact on traffic flows (e.g. junction of Surrey Canal Road and Trundley's Road); cyclists and pedestrians (e.g. Surrey Canal cycle path); parks (e.g. Folkestone Gardens, Fordham Park); business access (e.g. SELCHP). As such, it is important that these sensitivities are considered when planning the logistics of getting pipe to the various areas of the site.

4.11.3 We discussed options for storage and movement of pipes with a DH contractor. Their feeling was that it would be preferable to store pipe in a central storage area of approximately 30m x 30m and to then taken the pipes and fittings to the workface each day using a road going pipe truck,

4.11.4 The obvious places for a 30m x 30m space within the vicinity of the site are the two public parks – Folkestone Gardens and Fordham Park. Of the two, Fordham Park is larger, flatter and more open. As such, this would be the preferred position for a pipe storage and site welfare facilities.

4.11.5 It is noted that security around the area may be an issue and, as such, it will be necessary to provide a security guard to watch the site compound and storage area overnight.

SECTION 5

# INTERFACES AND ENABLING WORKS

# 5 INTERFACES AND ENABLING WORKS

## 5.1 Pipe network interface register

5.1.1 A pipe network interface register is provided in Figure 5-1.

## Figure 5-1: Pipe network interface register

| Network section | INTERFACES | | | | |
|---|---|---|---|---|---|
| | Existing utility interfaces | Land Owners (other than LBL adopted highway or public space) | Wayleaves required | Affected businesses | Others |
| SELCHP | N/A | SELCHP Ltd | Dependent on asset ownership | SELCHP Ltd | N/A |
| Landmann Way | Interoute - comms<br>SGN - LP gas<br>UKPN - power<br>BT - comms<br>Thames Water - water | N/A | N/A | British Wharf Industrial Est.<br>SELCHP Ltd.<br>Waste Reception Centre | N/A |
| Surrey Canal Road | BT - comms<br>Instalcom - comms<br>Interoute - comms<br>National Grid - HV power<br>SGN - LP & IP gas<br>UKPN - LV, HV & EHV power<br>SSE - comms<br>Thames Water - sewers & water<br>Vigin Media - comms<br>Zayo - comms | British Wharf Industrial Estate | British Wharf Industrial Estate | British Wharf Industrial Est.<br>SELCHP Ltd.<br>Waste Reception Centre<br>Juno Way Trading Estate | Relandscaping of soft dig area under rail bridge. Requires agreement with LBL.<br>Installation in cycle path to be agreed with LBL Cycle Programme team. Specific reinstatement standards.<br>Possible Asset Protection Agreement with Network Rail for installation under the rail bridge. |
| Trundleys Road | BT - comms<br>Instalcom - comms<br>Interoute - comms<br>SGN - LP & IP gas<br>UKPN - LV, HV power<br>SSE - comms<br>Thames Water - sewers & water<br>Virgin Media - comms<br>Zayo - comms | N/A | N/A | DD Scrap Metal<br>SEB Test Centre<br>Transweld<br>Slade Green Plating<br>Albany Waste Management<br>European Taste Restaurant | Route along perimeter of Folkestone Gradens to be agreed with LBL Parks department. Relandscaping design must also be agreed. |
| Sanford Street | EU Networks - comms<br>BT - comms<br>Instalcom - comms<br>Interoute - comms<br>UKPN - LV, HV power<br>SSE - comms<br>Thames Water - sewers & water<br>Vigin Media - comms<br>Zayo - comms | N/A | N/A | N/A | Possible Asset Protection Agreement with Network Rail for installation under the rail bridge. |
| Fordham Park | UKPN - LV power<br>BT - comms<br>SGN - LP & IP gas<br>Thames Water - sewers (deep) | N/A | N/A | N/A | Public space. Works methodology and reinstatement to be agreed with LBL Parks Department |
| Clifton Rise/Batavia Road | BT - comms<br>Thames Water - sewers & water<br>Virgin Media - comms<br>SGN - LP gas<br>UKPN - LV power | N/A | N/A | Choice Cars | Clifton Rise and Batavia Road both road bricks. Reinstatement to current standard. |
| Goodwood Road | SGN - LP & IP gas<br>BT - comms<br>UKPN - LV power<br>Thames Water - sewers & water<br>Virgin Media - comms | N/A | N/A | N/A | N/A |
| New Cross Road | BT - comms<br>Thames Water - sewers & water<br>Virgin Media - comms<br>SGN - LP gas<br>UKPN - LV power | TfL | N/A | N/A | TfL to approve access and methodology. Strict working time limitations. |
| St James's | SGN - LP & IP gas<br>BT - comms<br>Thames Water - sewers & water<br>UKPN - LV power<br>Virgin Media - comms | N/A | N/A | Goldsmiths, University of London | N/A |
| Goldsmiths campus | Thames Water - sewers & water<br>BT - comms<br>SGN - LP gas<br>UKPN - LV power<br>Virgin Media - comms<br>Goldsmiths comms network | Goldsmiths, University of London | Goldsmiths, University of London | Goldsmiths, University of London | Works programme to be coordinated with Goldsmiths to minimise disruption |

## 5.2 Section 50 License register

5.2.1 LBL Highways advise that a separate Section 50 license is required for every street in which works are taking place. They did note that in some cases, works in multiple streets can be amalgamated under one Section 50 license if they are taking place in a single project. Although that would be the case for the New Cross Heat Network, we have conservatively assumed that each street would need its own Section 50 license.

5.2.2 Note that Section 50 applications take up to three months to secure and works cannot commence without the Section 50 being in place.

5.2.3 A list of roads for which Section 50 notices will be required is presented in Table 5-1.

**Table 5-1: Section 50 notice requirement list**

| Section 50 license required |
|---|
| Landmann Way |
| Surrey Canal Road at Trundley's Road |
| Trundley's Road |
| Sanford Street |
| Clifton Rise |
| Batavia Road |
| Goodwood Road |
| St James's |
| Laurie Grove |
| Dixon Road |

## 5.3 Enabling works

5.3.1 The main priority for enabling this project is an extensive programme of trial holing and, if required, ground penetrating radar (GPR) along the proposed route. The requirement for site investigation is included in the network section analysis in Section 4 of this report; however the following provides some additional detail.

5.3.2 GPR can offer benefits to aid in DH network design, when depth information is required for existing services along a significant length, i.e. distances that would not be practicable for trial holing. In our experience, however, ground penetrating radar does not offer the certainty of trial holing due to e.g. difficulties in picking up well-balanced HV cable, as was the case with the GPR commissioned in the south side footway on Surrey Canal Road in the *Element A* report. It is also not uncommon for GPR to miss services or to pick up false readings from items other than utilities infrastructure such as large stones.

5.3.3 Although it is recommended that site investigations are undertaken across the whole of the proposed route between SELCHP and Goldsmiths, there several areas that appear to be particularly complicated. The junction of Surrey Canal Road and Trundley's Road, passing into Folkestone Gardens, contains multiple existing services including large intermediate and low pressure gas mains. A proposal for the design through this section is offered in Section 6.1; however it is not possible to develop a final design without site investigation to establish the exact position and depth of existing services. This junction is very sensitive to traffic disruption due to the significant industrial and commercial facilities nearby, including SELCHP, so it is important that the site investigations are planned to minimise disruption and are agreed/coordinated with LBL's Streetworks team.

5.3.4 The junction of Trundley's Road and Sanford Street is also heavily congested with existing services, including an intermediate pressure gas main. The proposed route is for the pipe to turn 90° out of Folkestone Gardens into the Trundley's Road carriageway (across the line of the intermediate pressure gas main) and then turn 45° down Sanford Street (see Figure 2-5). The point at which the pipe turns down Sanford Street depends on the exact location of other services in the carriageway. As such, this must be confirmed with trial holes before the depth and line of the DH pipework can be confirmed.

5.3.5 Trail holing across New Cross Road to establish a line and depth for the pipe will entail the closure of lanes on a TfL red route. The utilities mapping sourced for the purposes of this study (included in the *Element A* information pack) suggests that most of the services running along New Cross Road are in the footways. The trunk sewer running along the carriageway is indicated at over 11m deep on the Thames Water mapping, so would not affect the DH pipe installation. It is therefore recommended that GPR is used initially to establish whether there are any other services in the carriageway. If not, it may possible to proceed with installation without trial holing the carriageway. Note that trial holes will be required in the footways on both sides of the crossing to establish the depth of the services running through the footway and therefore the depth at which the DH should cross the carriageway.

5.3.6 Other than site investigations, there are several other key enabling works are to secure the necessary permissions from the various owners of land along the route. They are:

- **LB Lewisham:** Section 50 Licenses for installation of apparatus;
- **SELCHP:** Wayleave may be required for installation within the facility. This is dependent on the ownership status of the apparatus. If Veolia/SELCHP install the apparatus, a Wayleave would not be required;
- **British Wharf Industrial Estate:** Wayleave required for installation in their land on Surrey Canal Road;
- **TfL:** Consent for working underneath London Overground rail bridges at Surrey Canal Road and Sanford Street;
- **TFL:** Permission required for installation of apparatus in New Cross Road;
- **Goldsmiths, University of London:** Wayleave required for installation in their campus.

SECTION 6

# SITES OF ENGINEERING DIFFICULTY

# 6 SITES OF ENGINEERING DIFFICULTY

## 6.1 Junction of Surrey Canal Road and Trundley's Road

6.1.1 As described in Section 4.4, the junction of Surrey Canal Road and Trundley's Road has multiple factors that affect the design and installation of the pipework. Firstly, the junction is extremely busy, with multiple industrial and trading estates and SELCHP nearby.

6.1.2 There is significant gas infrastructure under the carriageway, as shown in Figure 6-1. Note the following colour identifications.

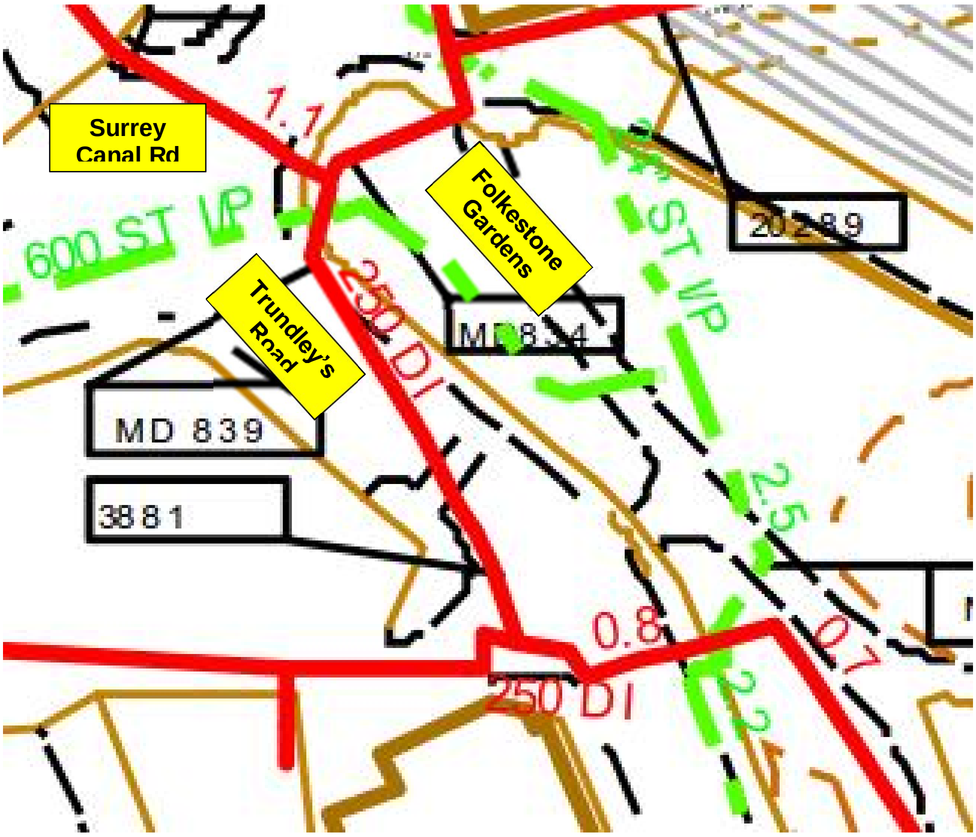
Red line = low pressure gas main

Green line = intermediate pressure gas main

Brown lines = kerb lines

Black lines = footpaths

**Figure 6-1: Gas infrastructure in the junction of Surrey Canal Road and Trundley's Road**




6.1.3 The gas map shows that there are two 600mm intermediate pressure gas mains (green lines) and a several 250mm low pressure mains (red lines) installed in this area. The depths indicated on the drawing show the intermediate pressure mains are between 2.2m and 2.5m and the low pressure mains are above, crossing Surrey Canal Road at approximately 1.1m deep. This is the depth to the crown of the pipe.

6.1.4 Discussion with Southern Gas Networks confirmed that a minimum clearance of 1.5 times the diameter of the pipe must be maintained from intermediate pressure gas mains. As such, there should be at least 900mm clearance between the DH pipe and the gas mains.

6.1.5 DH pipework has maximum depths at which they can be installed. This depth varies with pipe diameter and insulation thickness, as shown in Table 6-1.

**Table 6-1: LOGSTOR Series 2 maximum installation depth**

| DIA | Max depth (m) |
|---|---|
| 25 | 1.50 |
| 32 | 1.50 |
| 40 | 1.75 |
| 50 | 2.00 |
| 65 | 2.25 |
| 80 | 2.25 |
| 100 | 2.25 |
| 125 | 2.50 |
| 150 | 2.50 |
| 200 | 2.75 |
| 250 | 2.75 |
| 300 | 2.75 |
| 350 | 3.00 |

6.1.6 The *Element D* study concludes that pipe sizes across Trundley's Road would be 300mm for a peak load supply network and 200mm for a base load supply network.

6.1.7 The data table shows that for pipes between 200mm and 300mm in diameter, the maximum installation depth is 2.75m. If the intermediate pressure gas main is installed at approximately 2.5m to the crown of the pipe, the invert level of the pipe (the bottom of it) would be over 3m deep. As such, it is concluded that the DH mains could not be installed below the intermediate pressure gas mains at this point.

6.1.8 The DH pipe should therefore be installed above both the intermediate and low pressure gas mains. The gas drawing shows the low pressure gas main at approximately 1.1m to the crown of the pipe through this area. It is therefore proposed that the DH main should be installed with the invert level no deeper than 850mm, allowing a minimum of 250mm[5] clearance to the low pressure gas main below.

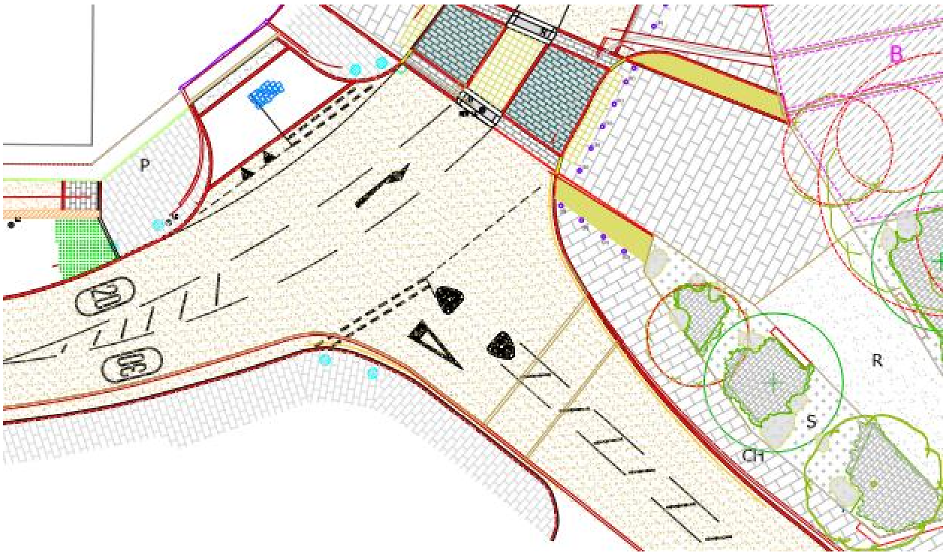
6.1.9 It is not possible to determine the exact depth of installation without trial holes. There are other services running through this area, including a 100mm water main; however

[5] 250mm is the minimum clearance required by Southern Gas Networks for installing infrastructure across the line of a low pressure gas main.

the Thames Water mapping provided in the *Element A* study shows that this is approximately 3.5m deep and is therefore expected to be below the intermediate pressure gas main. Should the pipe be installed at a depth shallower than 500mm, the construction designer of the heat network should consider the use of steel plates or a concrete raft to protect the pipe from the vertical load applied by the traffic using the road.

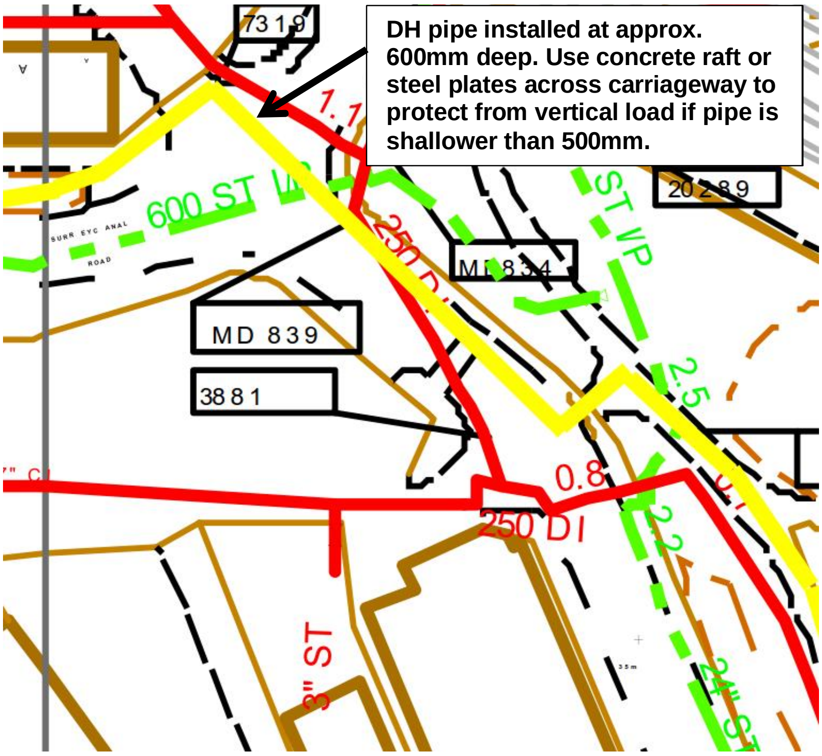
6.1.10 Another factor impacting on the junction of Surrey Canal Road and Trundley's Road is the remodelling of the road for a cycle network crossing. We have been provided with designs for the remodel and the crossing at Surrey Canal Road and Trundley's Road is shown in Figure 6-2.

**Figure 6-2: Cycle route design for the junction of Surrey Canal Road and Trundley's Road**




6.1.11 The design shows a new road crossing immediately to the east of the road junction, which will be comprised of granite blocks and tactile paving. In discussion with LBL Cycle Network officers, they stated that the DH installation should avoid this crossing if at all possible. Based on the position of gas infrastructure and the limitations imposed by the new cycle route crossing, a proposed line across the junction is presented in Figure 6-3.

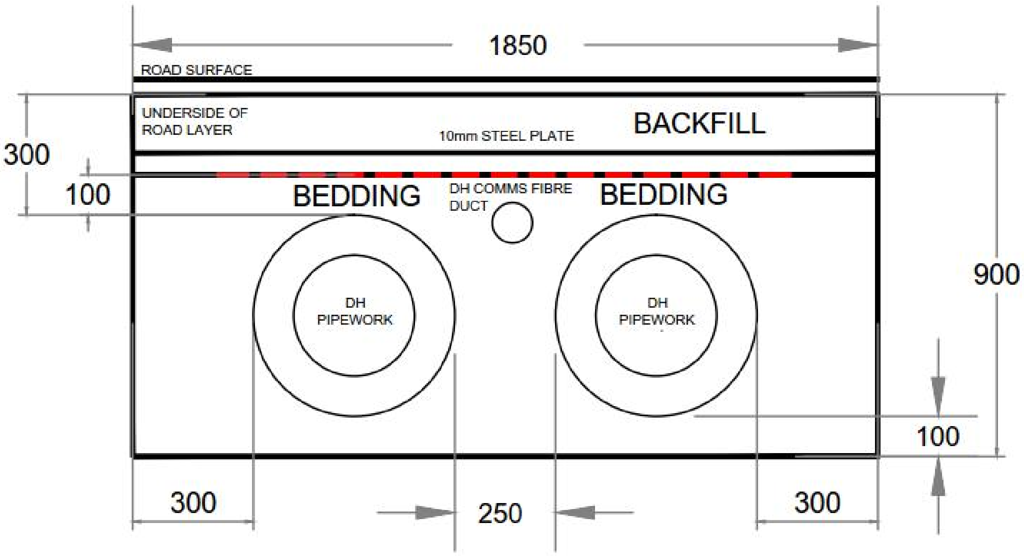
**Figure 6-3: Proposed pipe route (yellow) through junction of Surrey Canal Road and Trundley's Road – shown on gas infrastructure map (green = intermediate pressure mains; red = low pressure mains)**




6.1.12 In addition to the proposed pipe route, an indicative cross section of the trench through this junction is presented in Figure 6-4. This section makes allowance for the 250mm minimum clearance for the low pressure gas main at 1100mm (maximum DH pipe invert level of 850mm).

6.1.13 Note that because the pipe is installed at shallow depth, a steel plate is shown to protect against high vertical loading under the carriageway. The steel plate extends 300mm beyond the edge of the pipe to ensure protection from vertical loading. This has the impact of extending the trench width.

Figure 6-4: Proposed trench section across junction of Surrey Canal Rd and Trundley's Rd




## 6.2 Junction of Trundley's Road and Sanford Street

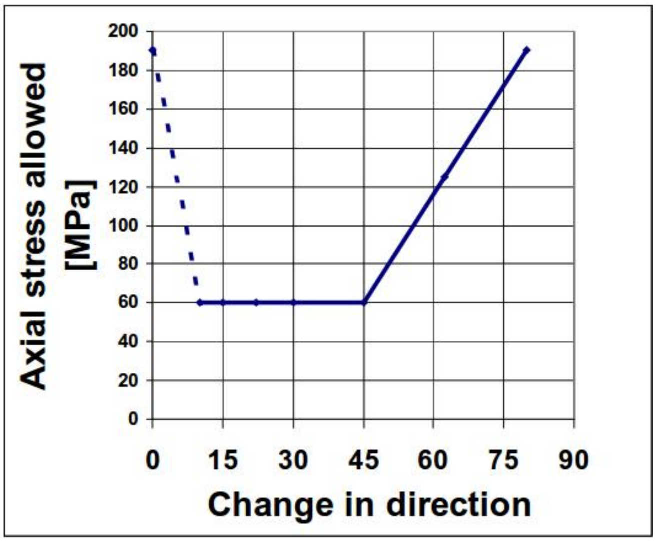
6.2.1 The junction of Trundley's Road and Sanford Street is also a site of engineering difficulty due to the natural angle of the DH pipe as it diverts off down Sanford Street.

6.2.2 Changes in direction on DH pipe can be achieved with curved pipe or with bends. Curved pipe can be beneficial as it minimises the frictional losses through the pipe, although bends are necessary at points on the network in order to take up expansion in the pipe (see Section 2.5.1).

6.2.3 Where bends are used, 90° bends are preferred to 45° bends due to the comparatively high radial expansion on a 45° bend. In some instances, however, 45° bends are necessary to achieve the required change in direction.

6.2.4 Manufacturer guidelines state that, in order to minimise the fatigue stress arising from radial expansion on a 45° bend, axial stress should be limited in the pipe, as shown in Figure 6-5, which is taken from Logstor design guidance.

Figure 6-5: LOGSTOR design guide for allowable axial stress on small angle bends



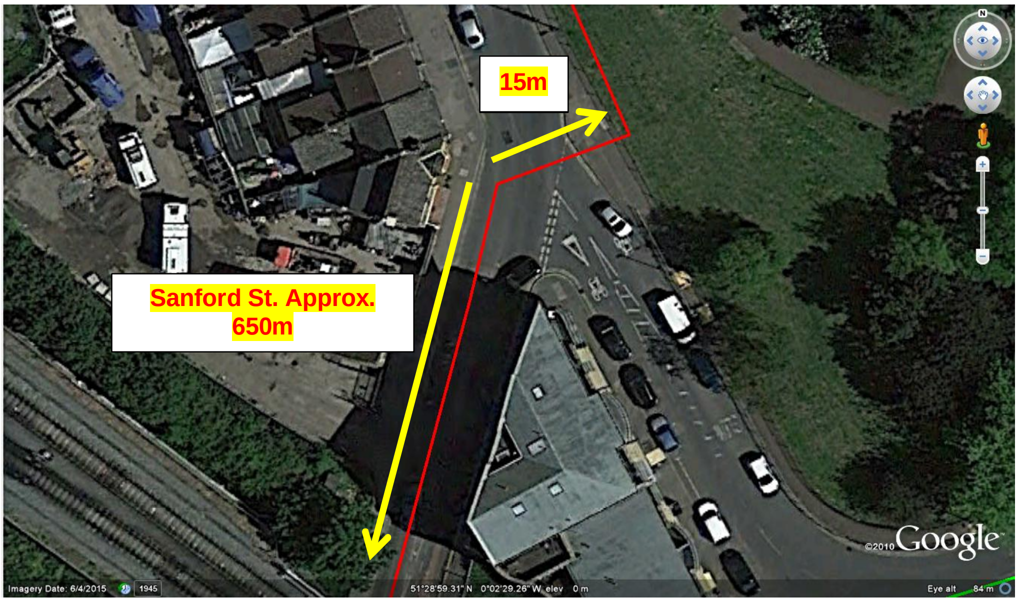

6.2.5 The chart shows how axial stress on a 45° bend must be limited to 60MPa in order to limit the fatigue stress arising from radial expansion. Section 2.5.1 explains how stress analysis on the rest of the network has been assessed with a maximum allowable stress level of 190MPa, so it can be seen how a small angle bend is subject to significantly reduced stress allowance compared to the wider network.

6.2.6 In order to limit axial stress to 60MPa, there must be 90° bends sufficiently close to the 45° bend. The *Element D* study concludes that pipe sizes at this point on the network would be 200mm for a future-proofed peak load supply network and 150mm for a future-proofed base load supply network (see Table 2-3).

6.2.7 Axial stress increases the deeper the pipe is installed. We have therefore assessed axial stress based on an installation depth of 1m for both 150mm and 200mm Series 2 pipe. Our assessment shows that, in order to limit axial stress to 60MPa, a 90° bend should be positioned no further than 27m either side of the 45° bend for a 200mm pipe and 23.5m either side of a 150mm pipe.

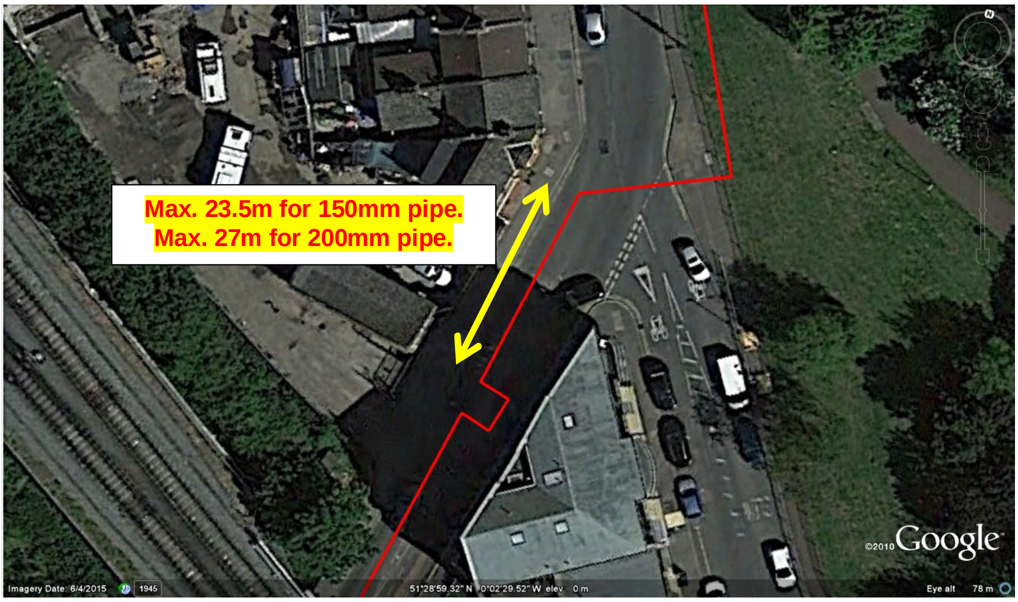
6.2.8 The proposed network geometry at this section is shown in Figure 6-6.

Figure 6-6: Pipe route at junction of Trundley's Road and Sanford Street




6.2.9 Figure 6-6 shows how, on one side of the 45° bend, there is 15m to the nearest 90° bend; however on the other side is Sanford Street, where there is only straight and curved pipe for 650m. As such, it is concluded that a 90° will be required 23.5m to 27m down Sanford Street (depending on whether the pipe is 200mm or 150mm) in order to limit the axial stress at the 45° bend, as shown in Figure 6-7. It may be possible to do this with a Z-bend, depending on the exact position of the pipe in the road; however it is more likely that a U-loop will be required so the pipe remains on the same line, as shown in Figure 6-7. The detailed design process will confirm the correct arrangement once GPR and trial hole information is available.

Figure 6-7: U-loop on Sanford Street to limit stress on 45° bend

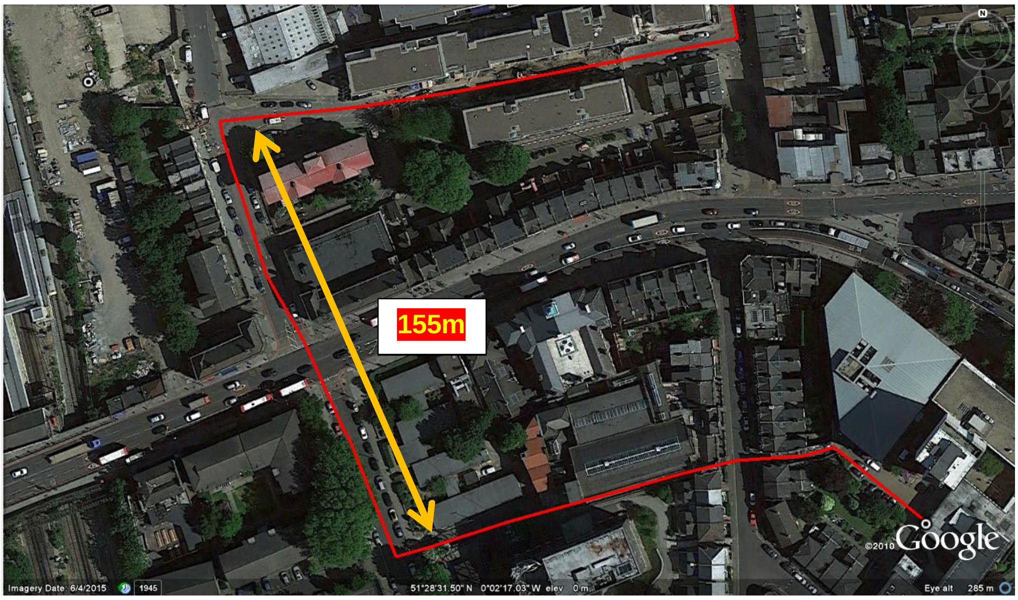


## 6.3 New Cross Road

6.3.1 The final section of the proposed route between SELCHP and Goldsmiths is Goodwood Road, crossing New Cross Road and on to St James's. The length of the pipe at this section is 155m, as shown in Figure 6-8.

6.3.2 The pipe diameter at this point is 150mm for a future-proofed peak supply network; or 100mm for a future-proofed base load supply network.

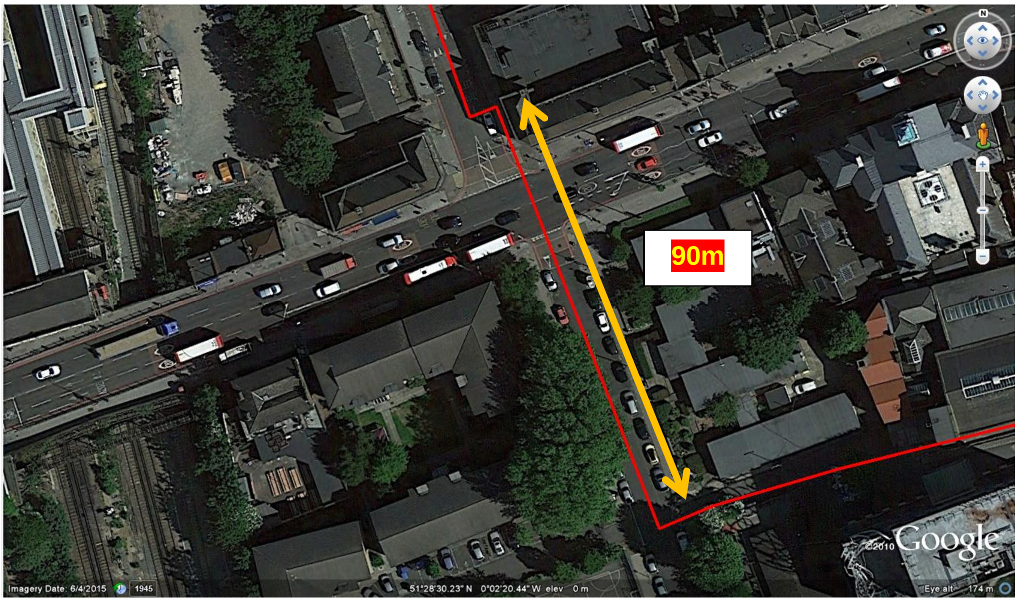
**Figure 6-8: Proposed route from Goodwood Road, across New Cross Road onto St James's**




6.3.3 If the network is designed for a maximum axial stress of 190MPa, the pipe must be installed at 600mm or shallower to avoid the requirement for stress reduction if it is a 100mm pipe. If it is a 150mm pipe, it must be installed at 800mm or shallower (see Table 2-4).

6.3.4 As this section of the pipe passes across New Cross Road – a TfL red route containing significant other major services and subject to very high traffic flows and working restrictions – it is proposed that a conservative approach to axial stress should be taken. In order to do this, it is possible to incorporate a natural bend in the pipework in Goodwood Road, as shown in Figure 6-9.

Figure 6-9: Possible Z-bend on Goodwood Road




6.3.5 Incorporating a Z-bend on Goodwood Road in this way would reduce the length of the straight section to approximately 90m. This reduces the axial stresses on the pipe section across New Cross Road significantly. As such, we propose that a Z-bend is included on Goodwood Road.

SECTION 7

# CONSTRUCTION RISK REGISTER

# 7 CONSTRUCTION RISK REGISTER

7.1.1 A construction risk register, detailing the hazards and the proposing mitigation measures is presented in the following pages.

| No. | Hazard | Persons at Risk | Initial Risk Assessment | | | Actions Proposed | Residual Risk Assessment | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Likelihood | Severity | Risk | | Likelihood | Severity | Risk |
| 1 | LV Electric shock | Contractor / Maintenance personnel | 3 | 5 | **15** | ▪ Earthing and appropriate IP rating<br>▪ Warning notices.<br>▪ Isolators for maintenance purposes with locking system.<br>▪ Bus bars in LV distribution are non-accessible.<br>▪ LV cables segregated from control & communication and HV cables.<br>▪ RCDs on low power circuits.<br>▪ Rubber floor mats.<br>▪ Armoured cables used for high power circuits and trunking for lower power.<br>▪ Adequate working space around equipment. | 1 | 5 | **5** |
| 2 | Using electrical tools | Contractor | 3 | 5 | **15** | ▪ Any electrical tools used during installation supplied via a 110V step down transformer | 2 | 5 | **10** |
| 3 | Potential risk of injury from contact with water from secondary system during connection of heat customer | Contractor / Maintenance personnel | 3 | 4 | **12** | ▪ Point of connection to be isolated and drained prior to new connection being made. | 2 | 4 | **8** |
| 4 | Manual handling of pipework and other items during installation | Contractor | 3 | 4 | **12** | ▪ Agreed procedures to be followed for handling and installation of pipework, valves etc. | 2 | 4 | **8** |
| 5 | Sparks and flash from welding or grinding or other hot work. Potential risk of fire and injury to operatives from burns and flash to eyes. | Contractor | 3 | 4 | **12** | ▪ Offsite prefabrication specified where possible to minimise on-site requirements to allow key works to take place in specialist controlled environment<br>▪ Suitable location of isolation and flange breaks for removal of maintainable | 2 | 4 | **8** |

| No. | Hazard | Persons at Risk | Initial Risk Assessment | | | Actions Proposed | Residual Risk Assessment | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Likelihood | Severity | Risk | | Likelihood | Severity | Risk |
| | | | | | | components<br>▪ Operatives to wear suitable PPE | | | |
| 6 | Installation tools and equipment. Potential risk of death or injury to operatives from defect or misuse. | Contractor | 3 | 5 | **15** | ▪ Ensure contractor operatives have appropriate accreditation, e.g. welding certificates.<br>▪ Require contractor enforces a site discipline system, e.g. red and yellow cards.<br>▪ Operatives to wear suitable PPE | 2 | 5 | **10** |
| 7 | Cutting noise. Potential ear injury to operatives during cutting operation. | Contractor | 3 | 3 | **9** | ▪ Offsite prefabrication specified where possible to minimise on-site requirements to allow key works to take place in specialist controlled environment.<br>▪ Suitable location of isolation and flange breaks for removal of maintainable components | 2 | 3 | **6** |
| 8 | System testing. Potential risk of death or injury to operatives from high pressure failure of seals. | Contractor | 2 | 5 | **10** | ▪ Use of mechanical joints at equipment and components only where possible.<br>▪ Low pressure systems to be incorporated where possible.<br>▪ Off-site testing of plant, equipment and modules in specialist controlled environment, where possible. | 1 | 5 | **5** |
| 9 | Collision with installation. Potential risk of injury to operatives. | Contractor / Maintenance personnel | 3 | 3 | **9** | ▪ Process systems and services layouts to ensure suitable access ways are maintained avoiding trip hazards and reduced head height crossing areas.<br>▪ Plant and equipment layout in accordance with supplier guidelines to allow adequate maintenance access. | 2 | 3 | **6** |

| No. | Hazard | Persons at Risk | Initial Risk Assessment: Likelihood | Severity | Risk | Actions Proposed | Residual Risk Assessment: Likelihood | Severity | Risk |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ▪ Suitable levels of lighting provided for all maintenance and access requirements.<br>▪ Operatives to wear suitable PPE | | | |
| 10 | Trapping in or collision with moving machinery during installation / maintenance | Contractor / Maintenance personnel | 2 | 4 | **8** | ▪ Strict procedures to be put in place during final works associated with the existing equipment that will eventually be removed.<br>▪ All field loads to have lockable isolators<br>▪ Public to be segregated from construction areas. | 1 | 4 | **4** |
| 11 | Risk of injury to public owing to works carried out on existing streets | Public | 3 | 4 | **12** | • Close streets where installation is taking place to vehicular traffic if necessary<br>• Provide protection / signage to divert users away from works areas<br>• Provide protection for pedestrian traffic during works. | 2 | 4 | **8** |
| 12 | Striking existing services – potential risk of death or injury to personnel as well as disruption of existing services | Contractor / Maintenance personnel | 2 | 4 | **8** | • Ground penetrating radar survey of areas before excavation.<br>• Contact asset owner in advance of excavation around major services, e.g. intermediate pressure gas main.<br>• Where existing services are located, use hand dig techniques.<br>• Install pipework with minimum clearances as specified by NJUG or, where applicable, asset owner for existing services. | 1 | 4 | **4** |
| 13 | Ground Contamination – risk to health of personnel from ingestion, inhalation or dermal contact with contaminated land | Contractor / Maintenance personnel / | 2 | 3 | **6** | • Ground investigation to commence in those areas where it is deemed to be necessary | 1 | 3 | **3** |

| No. | Hazard | Persons at Risk | Initial Risk Assessment | | | Actions Proposed | Residual Risk Assessment | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Likelihood | Severity | Risk | | Likelihood | Severity | Risk |
| | | Public | | | | • Method statement produced for remedial works<br>• Remedial works carried out as required | | | |
| 14 | Damage to London Overground rail bridges – risk to public safety and of disruption to train services | Public | 2 | 5 | **10** | • Consent required from TfL prior to works under the bridge<br>• Submit method statements to for approval as part of consent process<br>• TfL may want to supervise excavation under the bridge | 1 | 5 | **5** |
| 15 | Striking unexploded ordnance during excavation – risk to life of personnel and of disruption to residents, businesses and local transport if evacuation is required | Contractor / Maintenance personnel / Public | 2 | 5 | **10** | • UXO survey identifies the area as moderate risk<br>• Prepare an Emergency Response Plan in advance of the work<br>• Ensure all personnel are briefed as to the possibility of UXO in the area and receive information on the emergency response plan and evacuation procedures<br>• GPR survey prior to excavation may indicate any abnormalities beneath the surface | 1 | 5 | **5** |
| 16 | Trench collapse – risk of injury or death to personnel | Contractor / Maintenance personnel | 3 | 5 | **15** | • HSE guidelines to be followed at all times.<br>• Competent person to assess all trenches to determine requirement for reinforcement measures<br>• Use e.g. timber/sheet piling, drag boxes as determined by competent person<br>• Consider sloped trench where appropriate, as determined by competent person | 1 | 5 | **5** |
| 17 | Impact on local businesses | Public | 4 | 3 | **12** | • Engage local businesses prior to the | 3 | 2 | **6** |

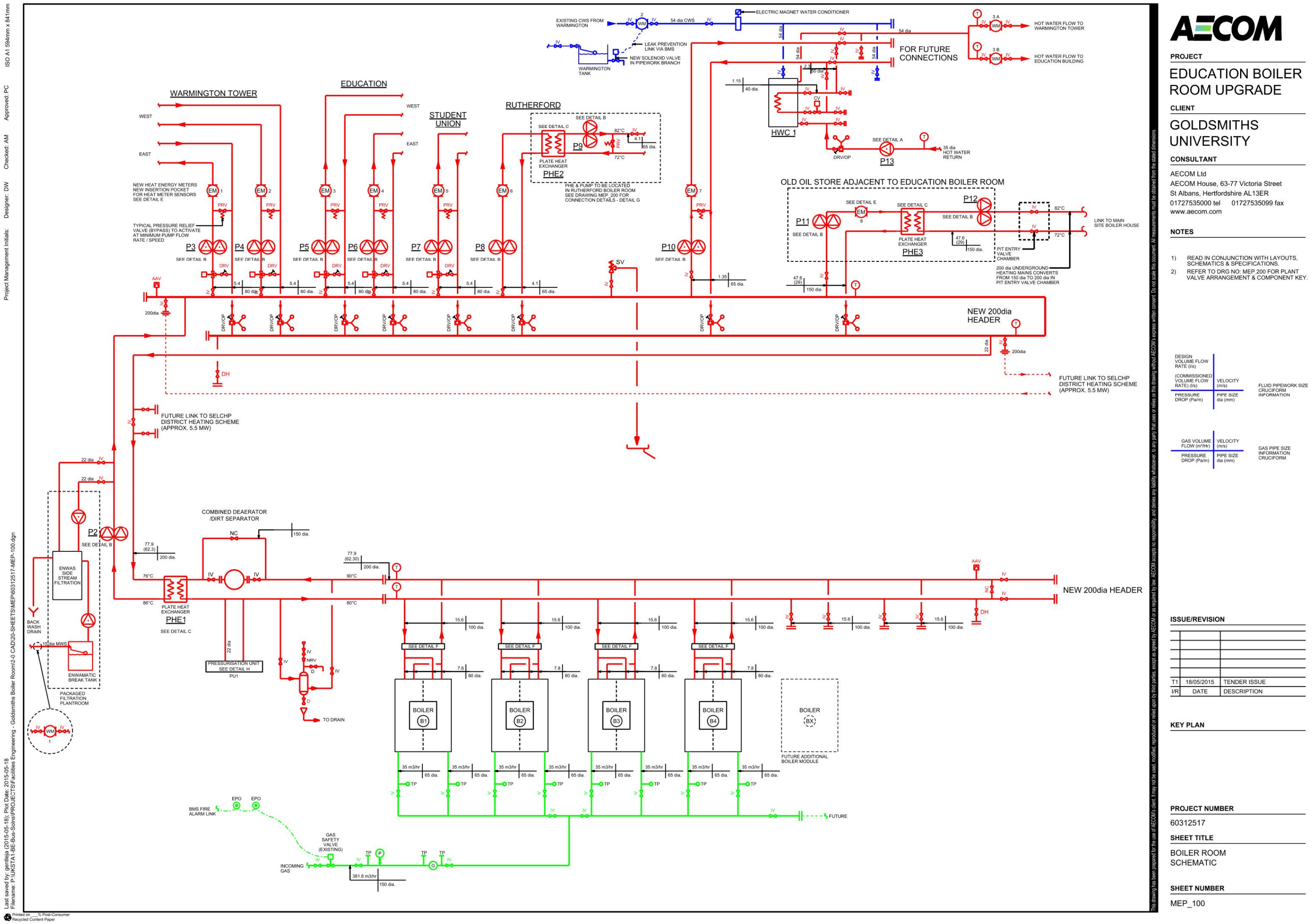
| No. | Hazard | Persons at Risk | Initial Risk Assessment | | | Actions Proposed | Residual Risk Assessment | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Likelihood | Severity | Risk | | Likelihood | Severity | Risk |
| | | | | | | works commencing to investigate mitigation measures and sequencing that limits the impact on their operations | | | |
| 18 | Impact on Goldsmiths | PUBLIC | 3 | 3 | **9** | • Work with Goldsmiths to programme works on the campus during holidays if possible | 2 | 2 | **4** |
| 19 | Poor reinstatement – roads, cycle paths, parks etc | PUBLIC | 3 | 3 | **9** | • Require client sign off of all sub-contractors to ensure civils team are experienced.<br>• LBL departmental sign off of all non-Highways reinstatement designs (parks, cycle paths etc).<br>• Ensure time for engineer/client sign off of all reinstatement. | | | |

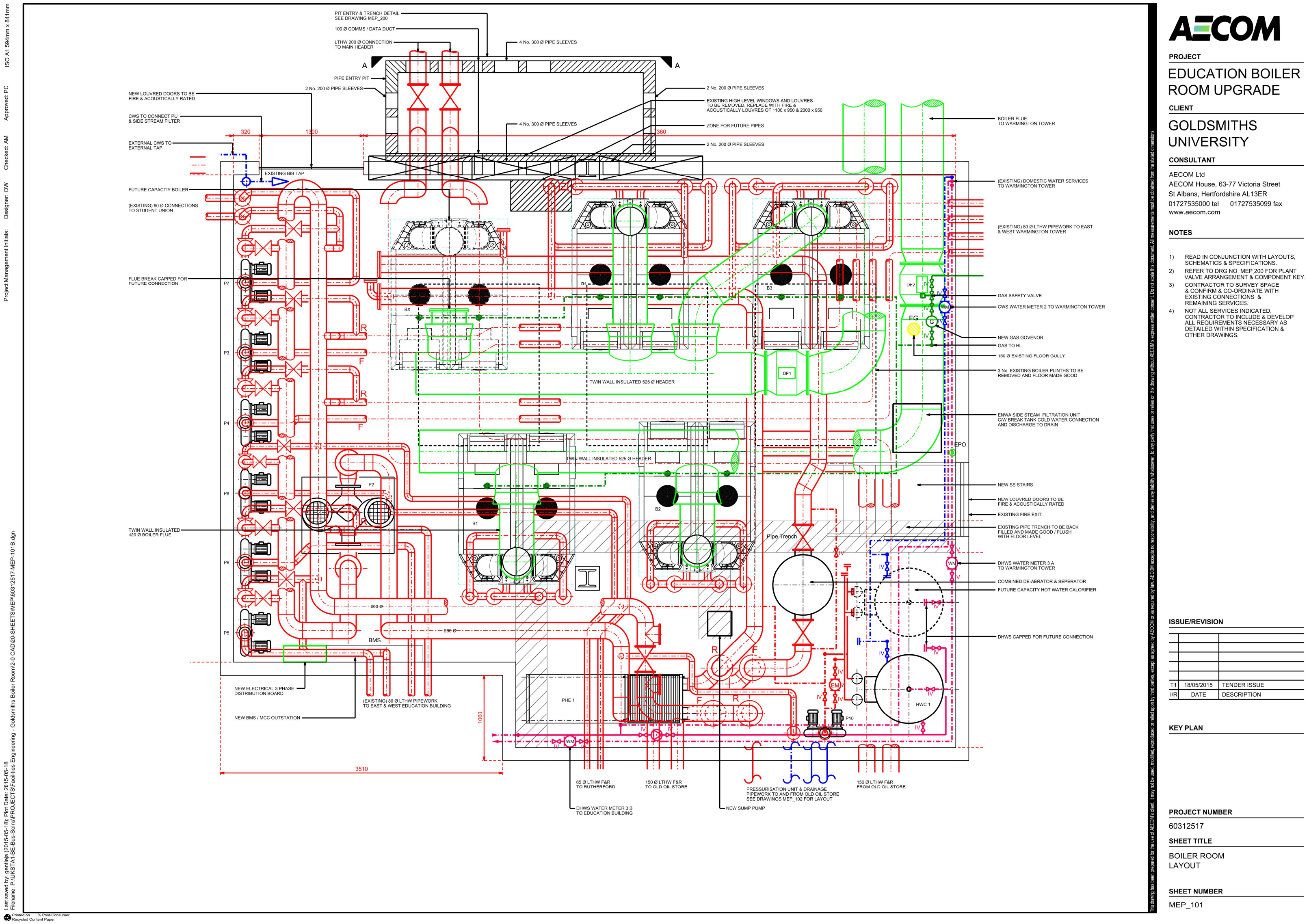
SECTION 8

# APPENDICES

# 8 APPENDICES

## 8.1 Appendix A – Goldsmiths Education Building schematic and layout


AECOM
PROJECT
EDUCATION BOILER ROOM UPGRADE
CLIENT
GOLDSMITHS UNIVERSITY
CONSULTANT
AECOM Ltd
AECOM House, 63-77 Victoria Street
St Albans, Hertfordshire AL13ER
01727535000 tel 01727535099 fax
www.aecom.com
NOTES
1) READ IN CONJUNCTION WITH LAYOUTS, SCHEMATICS & SPECIFICATIONS.
2) REFER TO DRG NO: MEP 200 FOR PLANT VALVE ARRANGEMENT & COMPONENT KEY.
ISSUE/REVISION
T1 18/05/2015 TENDER ISSUE
I/R DATE DESCRIPTION
KEY PLAN
PROJECT NUMBER
60312517
SHEET TITLE
BOILER ROOM SCHEMATIC
SHEET NUMBER
MEP_100
WARMINGTON TOWER
EDUCATION
STUDENT UNION
RUTHERFORD
OLD OIL STORE ADJACENT TO EDUCATION BOILER ROOM
FOR FUTURE CONNECTIONS
NEW 200dia HEADER
FUTURE LINK TO SELCHP DISTRICT HEATING SCHEME (APPROX. 5.5 MW)
COMBINED DEAERATOR /DIRT SEPARATOR
PLATE HEAT EXCHANGER
PHE1
PHE2
PHE3
HWC 1
PRESSURISATION UNIT
BOILER B1
BOILER B2
BOILER B3
BOILER B4
BOILER BX
FUTURE ADDITIONAL BOILER MODULE
INCOMING GAS
GAS SAFETY VALVE (EXISTING)
BMS FIRE ALARM LINK
TO DRAIN
HOT WATER FLOW TO WARMINGTON TOWER
HOT WATER FLOW TO EDUCATION BUILDING
EXISTING CWS FROM WARMINGTON
ELECTRIC MAGNET WATER CONDITIONER
LINK TO MAIN SITE BOILER HOUSE



PIT ENTRY & TRENCH DETAIL SEE DRAWING MEP_200
100 Ø COMMS / DATA DUCT
LTHW 200 Ø CONNECTION TO MAIN HEADER
4 No. 300 Ø PIPE SLEEVES
PIPE ENTRY PIT
2 No. 200 Ø PIPE SLEEVES
NEW LOUVRED DOORS TO BE FIRE & ACOUSTICALLY RATED
CWS TO CONNECT PU & SIDE STREAM FILTER
EXTERNAL CWS TO EXTERNAL TAP
EXISTING BIB TAP
FUTURE CAPACITY BOILER
(EXISTING) 80 Ø CONNECTIONS TO STUDENT UNION
FLUE BREAK CAPPED FOR FUTURE CONNECTION
TWIN WALL INSULATED 425 Ø BOILER FLUE
EXISTING HIGH LEVEL WINDOWS AND LOUVRES TO BE REMOVED. REPLACE WITH FIRE & ACOUSTICALLY LOUVRES OF 1100 x 950 & 2000 x 950
ZONE FOR FUTURE PIPES
BOILER FLUE TO WARMINGTON TOWER
(EXISTING) DOMESTIC WATER SERVICES TO WARMINGTON TOWER
(EXISTING) 80 Ø LTHW PIPEWORK TO EAST & WEST WARMINGTON TOWER
GAS SAFETY VALVE
CWS WATER METER 2 TO WARMINGTON TOWER
NEW GAS GOVENOR
GAS TO HL
150 Ø EXISTING FLOOR GULLY
3 No. EXISTING BOILER PLINTHS TO BE REMOVED AND FLOOR MADE GOOD
TWIN WALL INSULATED 525 Ø HEADER
ENWA SIDE STEAM FILTRATION UNIT C/W BREAK TANK COLD WATER CONNECTION AND DISCHARGE TO DRAIN
NEW SS STAIRS
NEW LOUVRED DOORS TO BE FIRE & ACOUSTICALLY RATED
EXISTING FIRE EXIT
EXISTING PIPE TRENCH TO BE BACK FILLED AND MADE GOOD / FLUSH WITH FLOOR LEVEL
DHWS WATER METER 3 A TO WARMINGTON TOWER
COMBINED DE-AERATOR & SEPERATOR
FUTURE CAPACITY HOT WATER CALORIFIER
DHWS CAPPED FOR FUTURE CONNECTION
Pipe Trench
NEW ELECTRICAL 3 PHASE DISTRIBUTION BOARD
NEW BMS / MCC OUTSTATION
(EXISTING) 80 Ø LTHW PIPEWORK TO EAST & WEST EDUCATION BUILDING
65 Ø LTHW F&R TO RUTHERFORD
150 Ø LTHW F&R TO OLD OIL STORE
PRESSURISATION UNIT & DRAINAGE PIPEWORK TO AND FROM OLD OIL STORE SEE DRAWINGS MEP_102 FOR LAYOUT
150 Ø LTHW F&R FROM OLD OIL STORE
DHWS WATER METER 3 B TO EDUCATION BUILDING
NEW SUMP PUMP
PHE 1
HWC 1
BMS
AECOM
PROJECT
EDUCATION BOILER ROOM UPGRADE
CLIENT
GOLDSMITHS UNIVERSITY
CONSULTANT
AECOM Ltd
AECOM House, 63-77 Victoria Street
St Albans, Hertfordshire AL13ER
01727535000 tel 01727535099 fax
www.aecom.com
NOTES
1) READ IN CONJUNCTION WITH LAYOUTS, SCHEMATICS & SPECIFICATIONS.
2) REFER TO DRG NO: MEP 200 FOR PLANT VALVE ARRANGEMENT & COMPONENT KEY.
3) CONTRACTOR TO SURVEY SPACE & CONFIRM & CO-ORDINATE WITH EXISTING CONNECTIONS & REMAINING SERVICES.
4) NOT ALL SERVICES INDICATED, CONTRACTOR TO INCLUDE & DEVELOP ALL REQUIREMENTS NECESSARY AS DETAILED WITHIN SPECIFICATION & OTHER DRAWINGS.
ISSUE/REVISION
T1 18/05/2015 TENDER ISSUE
I/R DATE DESCRIPTION
KEY PLAN
PROJECT NUMBER
60312517
SHEET TITLE
BOILER ROOM LAYOUT
SHEET NUMBER
MEP_101

## 8.2 Appendix B – Future Connections Specification

PARSONS BRINCKERHOFF

November 2015

# NEW CROSS HEAT NETWORK: NEW CONNECTIONS SPECIFICATION

*London Borough of Lewisham*

[3513044A-BEL]

***Final***

# New Cross Heat Network: New Connections Specification

**3514033A-BEL**

**Prepared for**
London Borough of Lewisham

**Prepared by**
WSP | Parsons Brinckerhoff

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## CONTENTS

# 1 INTRODUCTION

This document describes the hot water and space heating design strategies to be considered in all buildings which are to be connected to a district heating network.

This document is compliant with the guidelines set out in the CIBSE *Heat Networks Code of Practice for the UK*.

The ideal design philosophy for a district heating network is based on constant operational flow and return temperatures and variable flow rate, to suit the annual fluctuations in customer demand. The following guidelines are provided to suit this operational philosophy.

The following terminology will be used to describe the various sub-systems that are dealt with in this document:

System definitions

- **LTHW** stands for Low Temperature Hot Water supply.
- **DHW** refers to Domestic Hot Water supply.
- **DH** stands for District Heating.
- **HWS** refers to Hot Water Service supply (i.e. non-domestic hot water)
- **SELCHP** stands for South East London Combined Heat and Power.
- **DP** stands for Differential Pressure.
- **CT** stands for Constant Temperature.
- **VT** stands for Variable Temperature.
- The **primary network** refers to the primary distribution system that connects SELCHP to each individual building or development.
- **District Heating Substation** located in the developer plant room is the physical (and contractual) delineation between the primary and secondary networks.
- The **secondary networks** are the local networks within each building or development that supply hot water to the end user.
- **HIU** stands for Heat Interface Unit.

## 2 THE PRIMARY NETWORK

The primary New Cross Heat Network will be a variable flow rate system that is controlled by the individual instantaneous heating demands of the connected buildings. A constant temperature differential is imposed on the primary circuit irrespective of the demand requirement, with the return temperature kept as low as possible to maximise the thermal efficiency of the network, and to minimise pumping costs.

To meet these requirements, it is essential that the primary and secondary networks are compatible in their design. The main purpose of this document is to provide guidance on the design of the secondary circuits, i.e. the heating systems within connected buildings, so that the primary network can operate at its optimum efficiency.

## 3 SECONDARY NETWORKS

A heat exchanger substation shall form the hydraulic interface between the primary district heating network and the new connection's secondary system(s). The advantage of using a heat exchanger is that it provides hydraulic separation of the two circuits, creating a contractual demarcation and eliminating the risk of contamination to the primary system from the customer secondary systems and vice versa.

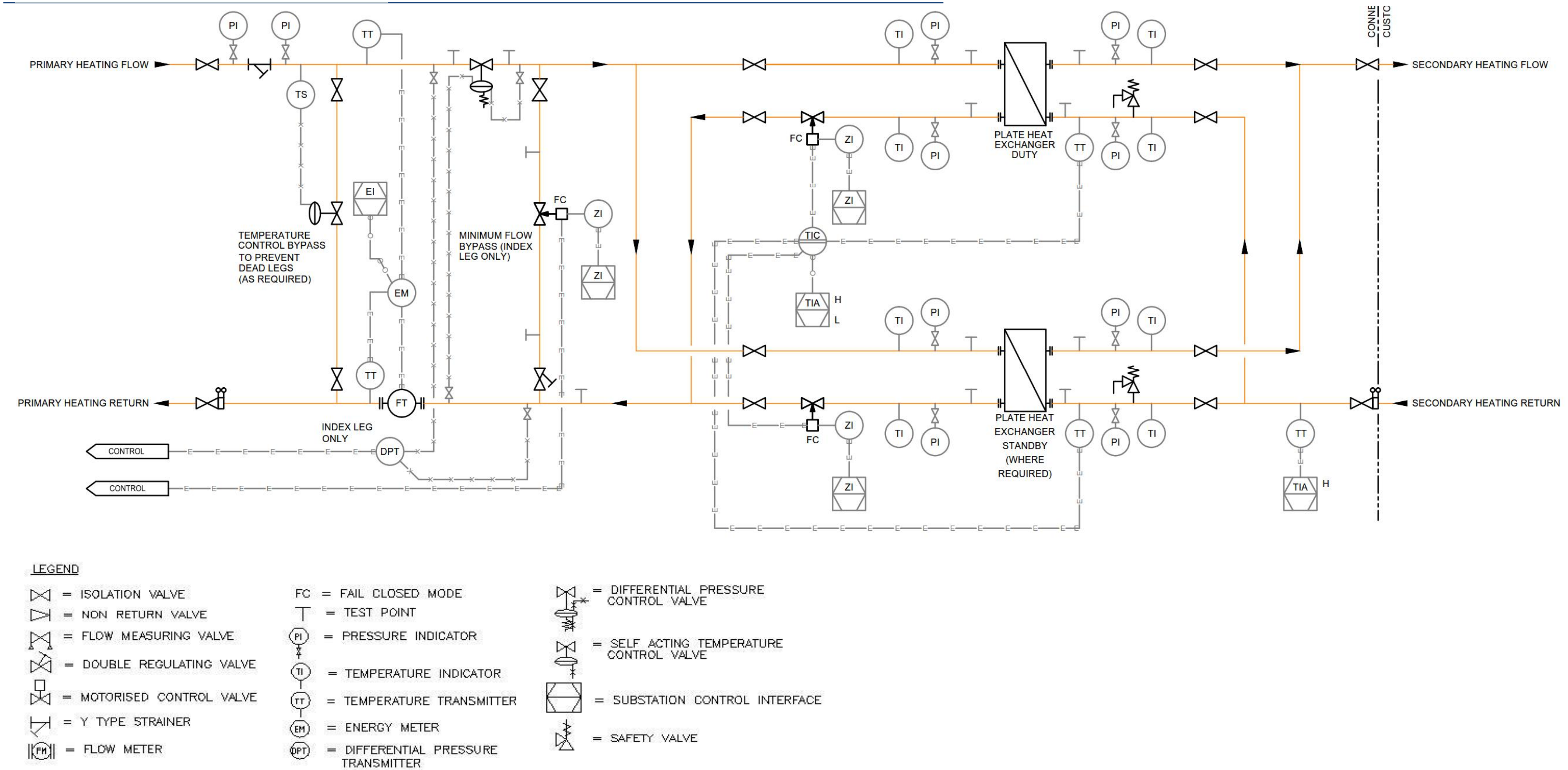
The substation shall be located in a plant room within the connected development/building. To achieve compatibility with the primary network, it is important that these substations are designed, installed and operated to a common set of rules that are described in the next section.

Within new-build residential connections, the secondary system generally supplies heat to tertiary LTHW and DHW systems located in individual residential units via a Heat Interface Unit (HIU). These units can be thought of as scaled-down version of the heat substations, and are comparable in size to a modern domestic condensing boiler. However, unlike the large substations, which are designed for specific buildings, the HIU is generally an off-the-shelf item that is selected to meet the required load specifications. These HIUs are essential to the efficient operation of a DH network and it is noted that the market does not currently benefit from a quality standard, which means there is a lot of variation in the efficiency and quality of the available units.

It is essential that the interface between the primary and secondary networks has a common set of features. The following drawing gives a typical schematic indication for the connection requirements at the interface between the primary DH circuit and the relevant building secondary systems. It should be noted that this drawing is for guidance and information only and each connection should be co-ordinated as required with the end user for final design and installation requirements.

The drawing indicates two heat exchanger units operating in parallel; however, depending on the required load of the individual connection, along with any specific resilience requirement, the substation may incorporate single or multiple parallel heat exchangers, or a level of standby. Subject to this final required configuration, the controls can vary to suit each requirement type.

The physical requirements for the incorporation of the heat exchange substation in the developer plant rooms are detailed in Section 6 below.



PRIMARY HEATING FLOW
PRIMARY HEATING RETURN
SECONDARY HEATING FLOW
SECONDARY HEATING RETURN
PI
TT
TS
TI
EI
EM
FT
DPT
ZI
TIC
TIA
H
L
FC
TEMPERATURE CONTROL BYPASS TO PREVENT DEAD LEGS (AS REQUIRED)
MINIMUM FLOW BYPASS (INDEX LEG ONLY)
INDEX LEG ONLY
CONTROL
CONTROL
PLATE HEAT EXCHANGER DUTY
PLATE HEAT EXCHANGER STANDBY (WHERE REQUIRED)
LEGEND
= ISOLATION VALVE
= NON RETURN VALVE
= FLOW MEASURING VALVE
= DOUBLE REGULATING VALVE
= MOTORISED CONTROL VALVE
= Y TYPE STRAINER
= FLOW METER
FC = FAIL CLOSED MODE
= TEST POINT
= PRESSURE INDICATOR
= TEMPERATURE INDICATOR
= TEMPERATURE TRANSMITTER
= ENERGY METER
= DIFFERENTIAL PRESSURE TRANSMITTER
= DIFFERENTIAL PRESSURE CONTROL VALVE
= SELF ACTING TEMPERATURE CONTROL VALVE
= SUBSTATION CONTROL INTERFACE
= SAFETY VALVE

### 3.1 Return temperatures

The maximum available temperature from SELCHP for heat supply to the New Cross Heat Network is 110°C. Given the constraints on pipework installation in the New Cross area (discussed in Element A and C reports), it is preferable to maximise the temperature differential between the primary flow and return so as to allow pipe sizes to be minimised.

The use of a hydraulic separation at the heat exchange substation in the developer plantrooms means that low temperature secondary systems can be supplied from a higher temperature primary network. This approach allows for a maximum temperature differential on the primary network, which can be further enhanced with secondary system designs that prioritise low return temperatures.

The range of possible primary return temperatures for a DH network is presented below.

| Position in temperature range | Temperature |
|---|---|
| Return temperature (maximum) | 75°C |
| Return temperature (nominal) | 65°C |
| Return Temperature (optimal) | 50°C[1] |

It should be an obligation of the building designers to provide suitable secondary system designs that ensure the return temperature to the primary system at each interface is maintained in line with the agreed maximum throughout the demand range.

The viability of achieving a given return temperature depends on whether the new connection is a new development or an existing building. For new developments, secondary and tertiary systems can be designed to achieve optimum return temperatures. For existing buildings where secondary and tertiary systems are already in operation, system modifications can be undertaken to ensure a constant return temperature and, potentially, reduce return temperatures to some degree; however it is unlikely that an optimal primary return of 50°C could be achieved, based on what is likely to be a traditional design approach with regard to temperatures.

It is recommended that the requirement to provide an agreed return temperature to the DH network should be maintained throughout the annual demand profile down to an acceptable minimum requirement of nominally 10% of the maximum demand. At this point, return temperatures may rise due to the minimum flow rate on the secondary system being above the required flow rate at very low load.

Suggested secondary side temperatures are given in the table below. Secondary return temperatures should be kept as low as possible to improve the operational efficiency of the primary network. It is noted that, depending on the secondary system design, there may be an additional point of interface between the secondary distribution system and the tertiary heating system – the HIU. The temperatures below refer to the range of possible return temperatures at the end user, which would be the tertiary system where an HIU is installed.

[1] For residential developments this optimal figure can be challenged even further with the potential to get as low as 35°C to 40°C subject to final selection of heating circuit type.

| Operating Parameter | Optimum | Nominal | Max[2] |
|---|---|---|---|
| Secondary Return Temperature – existing buildings | <50°C | 60°C | ~70°C |
| Secondary Return Temperature – new buildings[3] | 40°C | 50°C | 60°C |

### 3.2 General operating requirements

General requirements for heating interface are summarised as follows:

- The primary network will generally be sized for a maximum working pressure of 10bar[4]
- The head loss at the primary circuit connections within the building and the plant room shall be a maximum of 1bar.

As shown in the schematic drawing, the flow rate through the sub-station is regulated by the motorised control valve (CV). A differential pressure control valve (DPCV) should also be installed at each connection, with the actuator capillary lines connected across the heat exchanger and / or the CV. Once commissioned, the DPCV will self-regulate to maintain the maximum design differential pressure setting, irrespective of fluctuations within the main system and will close down in parallel with any flow regulation requirement of its associated CV, which regulates to suit the demand of the connection.

A form of flow measurement device will need to be included at each connection to allow for flow checks and to commission the installed DPCV. This could be in the form of a flow-measuring orifice or, where energy metering is incorporated at the connection, the flow-sensing element of this package can be used. Suitable test points should also be installed across various items of equipment, as indicated on the schematics. These test points serve the purpose of confirming temperatures, establishing flow rate and detecting any fouling at the heat exchangers or strainers.

Due to their compactness and their ability to operate with close approach temperatures between the primary and secondary return, the heat exchanger at the substation is generally a plate type heat exchanger. One of the benefits of these systems to the developer is the potential for additional space, since heat exchanger substations are significantly smaller than conventional boiler plant (occupying as little as one tenth of the space). However, because plate heat exchangers are prone to fouling filtration is essential, as is the water treatment regime of both the primary and secondary circuits.

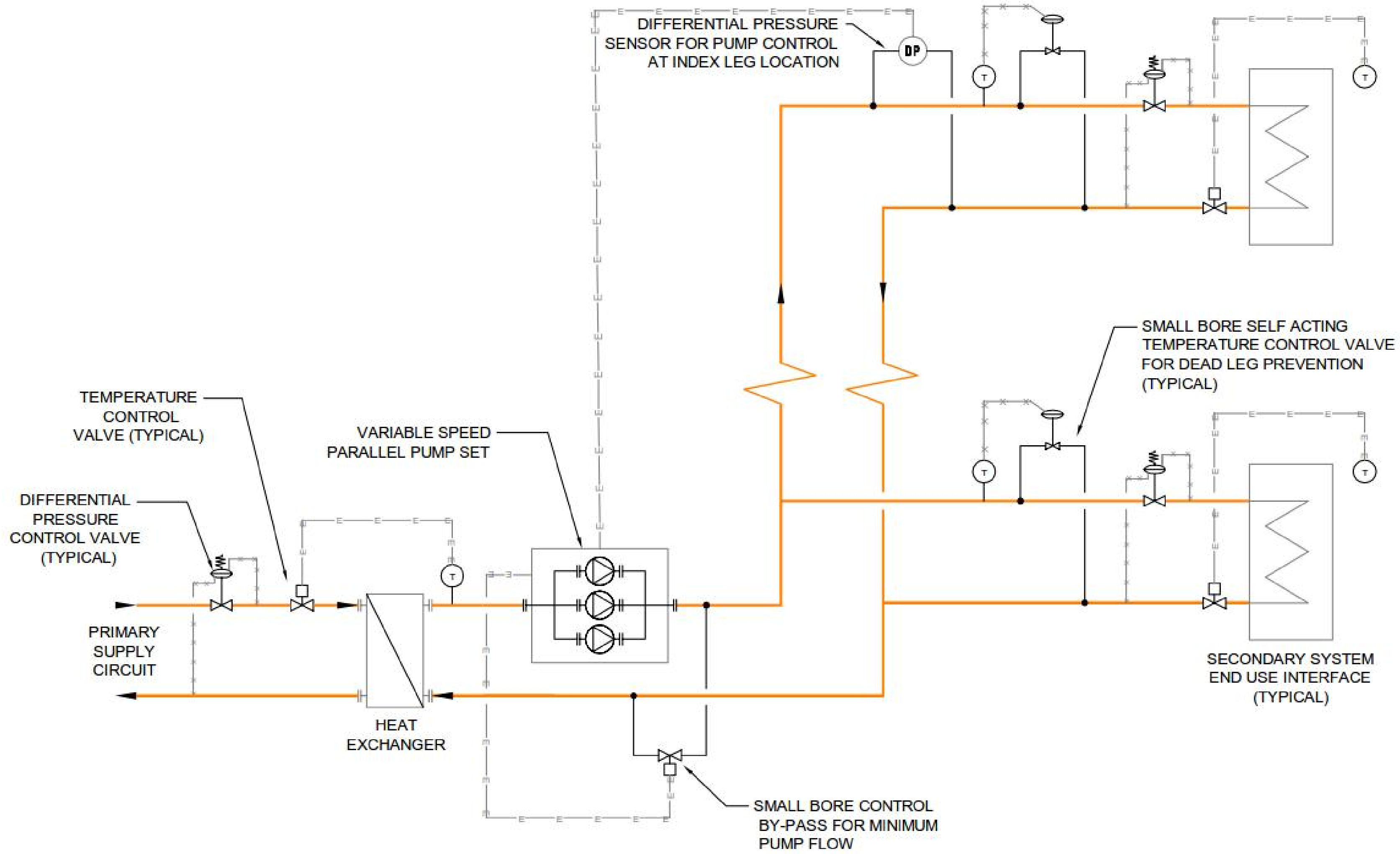
[2] Max temperature refers to maximum transient/low load condition rather than maximum design condition.
[3] Conditions for new build based on CIBSE AM12 guide, which advocates the use of 70/40 flow/return temperatures for modern systems and the DH Manual for London Table 8 Design Standards.
[4] DH pipework is available at PN16 or PN25 ratings; however the system pressure is limited by the maximum working pressure of the heat interface equipment, which is typically 10bar.

# 4 SECONDARY SYSTEM DESIGN

## 4.1 General operating philosophy

Secondary systems shall be designed based on constant operating temperatures and variable flow rate criteria to ensure full compatibility with the primary supply systems. The following drawing indicates the basic concept of variable speed pumping and two-port control strategy.

**Figure 4-1: Indicative DH system interface design**



The required terminal load is used to regulate the control valve opening, ensuring that the pump is kept at the optimum operation point for the overall circuit. This keeps the electrical consumption of the pump to a minimum and maintains a maximum temperature differential between the flow and the return.

It is recommended that the pump speed regulation is controlled through differential pressure measured at the secondary circuit index run, as shown in Figure 4-1. This is normally the most distant load and ensures an accurate and close tolerance reaction to changes in the system demand parameters, as valves open and close.

It is not correct to control a variable flow circuit with the overall system differential pressure at the pumps, which is seen in practice on many installations, as a set point DP for peak will be significantly different to the requirement at minimum demand. The only suitable alternative to an index leg control, for example where no controls network is available to a residential scheme, is to utilise a specialist packaged intelligent pumping system that is available from certain pump suppliers. This works on a commissioned setting for peak and minimum demand. Based on a matrix of absorbed power for the particular pumps being used, the system knows where the pumps need to be on their speed curve. The only downside to this solution is it is initially based on theoretical figures and needs to be checked / re-commissioned as necessary based on actual parameters once known. It also requires adjustment if further connections are added where the system dynamics will change.

Due to the possibility that, at times of very low load, the required system flow rate may be exceeded by the minimum possible flow rate at the pumps' minimum speed setting, it is necessary to install a small bore control bypass arrangement so that the pumps can maintain minimum flow, as shown in Figure 4-1. The bypass control valve should be set to open when the single smallest pump reaches its minimum speed and the differential pressure set point continues to rise.

It is also recommended that any final connection heat interface, that is prone to a long length of potential dead leg, is fitted with a small bore self-acting temperature control valve to maintain a suitable level of heat close to the connection when the control valve is closed, such that when heat is required, the reaction time to provide a suitable temperature is negligible. This is also as shown in Figure 4-1 and described further in Section 4.1.2 below. Depending on the reaction times required these can alternatively be located on the end of main headers to cover multiple connections.

The temperature differential in the secondary distribution networks must be kept as high as possible to ensure efficient operation of the DH network. The temperature differential at the primary / secondary interface will depend on the design of the internal building services. Therefore, all internal systems must ensure compatible design that maintains optimum differential temperature at the interface during all demand scenarios.

Key considerations for the design of building internal systems are as follows:

- Selecting low temperature operating systems such as underfloor heating to significantly reduce return temperature.
- Where underfloor heating is not acceptable or feasible, low flow rate radiator circuits for buildings, complete with thermostatic control, should be adopted. Radiator circuits can be

designed to operate satisfactorily down to as low as 40°C-30°C without compromising the ability of the system to deliver the required level of heat, given the new build requirements for fabric loss. This is as opposed to the traditional 82°C / 71°C approach. Quite often, boiler plant, pipework and radiators are oversized and therefore the modified conditions can be applied to existing systems without any loss of performance in the heating system (see Section 5).

- Compensated control to provide a variable temperature (VT) circuit to radiator and similar heat emitters will then optimise return temperatures further as the ambient temperature moves away from the winter peak requirements.

- Lower system operating temperatures ((i.e. below the traditional 82°C flow temperature) can also be applied to constant temperature (CT) type circuits serving air handling unit (AHU) and fan coil unit (FCU) connections.

- In line with the sections covered below, the fundamental solution should involve a variable flow rate system in line with demand profile to ensure constant temperature differential operation to absolute minimum demand scenario.

- Ensuring minimum return temperature from hot water service connections, whether storage or instantaneous. This can be as low as 25°C during high draw off times (see Section 4.1.5).

- Instantaneous hot water generation should be considered.

### 4.1.1 Two-port Control Valves and Variable Speed Pumping

The use of two port control valves and variable flow operation in constant temperature system applications is fundamental in ensuring that the unnecessary return of supply water temperature back to the heat exchanger is avoided. The use of variable speed pumps, in conjunction with differential pressure control valves for system balance, provides an efficient method of delivering only the energy that is needed and, when combined with parallel pumping (see Section 4.1.4), provides the required turn down of the system to maintain optimum return temperatures throughout the annual demand profiles.

### 4.1.2 “Dead leg” control

Bypass arrangements should be kept to an absolute minimum. They will be necessary during low demand periods when the supply temperature on the primary and secondary network deteriorates due to control valves remaining closed for a period of time. If flow by-passes are not controlled properly, the system loses efficiency because even at peak times, there is a continual mix between the flow and return streams. To overcome this, self-acting temperature control by-passes should be installed at the end of main branch legs or at any remote equipment connections. These should be adjusted so that they open within a predetermined tolerance of the design flow temperature set point. This will allow a small constant flow to occur during low demand periods, to prevent the occurrence of “dead legs”.

It should be noted that short “dead legs” are perfectly acceptable on large-scale two port control systems and that as long as there is a main system branch, in reasonably close proximity, which is maintained at the design flow temperature, there is no need to install these bypasses over and above where they are absolutely necessary. The actual size of the by-pass and self-acting valve, where essential, should be kept to the smallest bore that will allow the flow rate required to maintain the "dead leg" at a minimum designated temperature (this figure should be less than the design operating temperature for example, the setting on a 60°C circuit could be 50-55°C.

### 4.1.3 Circuit Mixing

Wherever possible, water returning from one heating circuit at a high temperature should be considered for use in a second circuit. However, it is appreciated that this is not always possible since one circuit may demand energy at a different time to another.

### 4.1.4 Pump Selection Methodology

It is recommended that the required pumps are installed in parallel within the flow circuit just after the heat exchanger, as shown in the following drawing. Differential pressure control is then incorporated in each sub-circuit after the pump, to provide system balance during all demand scenarios and flow / pressure fluctuations. The number of pumps selected will depend on the maximum and minimum flow rates at which the system will operate throughout the year and the characteristics of the inverter of the variable speed pump.

For connections where the difference between the annual maximum and minimum demands is less onerous than others, a single duty pump may have sufficient turndown capacity to meet the required operation throughout the year. For most connections the difference in loads throughout the year is significant and therefore, to be able to meet the required return temperature at all times, the use of parallel pumping should be adopted. Again dependant on the flow rate differences between the annual maximum and minimum demands, this can mean two 50% units, three 33% units and/or the incorporation of a low load (jockey) pump.

The minimum flow requirements described above should be based on the minimum speed requirement for a single pump in the parallel set up. Note that minimum flow for the pump is not necessarily in line with the minimum inverter setting and the pump may be allowed to ramp up its curve at this speed before final prevention of dead head is required.

Pump selection should seek to maintain a degree of resilience is case of pump failure or maintenance; for example three pumps at 50 percent of the peak requirement in a duty/duty/standby arrangement.

### 4.1.5 Hot Water Supply

The generation of hot water services (HWS) is generally supplied from the customer secondary side system and should be designed such that the mix of return temperatures from this and the other heating circuits will provide the overall required return temperature. Consideration needs to be given to pump control where this is a dedicated circuit at the times when no demand is required otherwise the return temperature will rise from this connection.

The most efficient solution for return temperature and annual pumping savings is to connect the HWS as a separate primary interface with the DH supply. Subject to individual customer resilience requirements for HWS supply, consideration should be given to an instantaneous approach. This provides the benefit of not only space reduction, heat loss reduction from standing water and the reduction of the risk of infection from Legionella, but will also benefit in providing a minimum return temperature where the cold feed is connected directly to the heat exchanger. Packaged HWS substations that are fully compatible with a DH connection are widely available as both instantaneous or with a required level of storage.

The DHW supply for all residential units shall ideally be generated locally via a Hydraulic Interface Unit (HIU). The HIU shall typically be a wall mounted packaged unit comprising 2No heat exchangers (1No for heating, 1No for DHW), a heating circulation pump, control devices and heat metering for billing purposes.

#### 4.1.6 BMS

Exchange of BMS data should be provided as required to ensure ongoing operational compatibility between the district heating primary and the secondary circuits. The Energy Centre will continually monitor the flow and return temperatures on both the primary and secondary sides of the substation interface, as well as the primary flow rate, primary valve position(s), instantaneous energy consumption and cumulative energy consumption for billing. The provision of these signals will allow for full diagnosis of the interface performance and where any compatibility issues may arise. Note that further control signals may need to be provided by the secondary system subject to the final complexity of the substation connection.

An electrical enclosure and control panel would be installed to house control devices and the communication system link to the energy centre. This will be capable of transmitting the data obtained from the installation, as described above, as well as alarms and receiving control inputs.

#### 4.1.7 Metering

Energy meters measure the volume flow rates as well as the flow and return temperatures to provide an accurate record of energy usage. The preferred flow meter element technology is an ultrasonic or similar full pipe bore type device that should be to a minimum Class 2 in accordance with the *Measuring Instruments Directive*. These solid state devices are less susceptible to deposits in the water because they contain no moving parts. Furthermore they require very little maintenance and are accurate even with very low flow rates, although it is essential that selection is based on both the maximum and minimum operating requirements.

Metering is generally installed to record energy delivered on the primary side circuit for reasons of demarcation; however check meters can be installed as required on the secondary side. The energy metering system must include a flow meter, two temperature sensors and a stand-alone integrator unit complete with battery backup. No energy metering should be carried out within the main BMS logic.

Note that metering must be compliant with the *Heat Networks (Metering and Billing) Regulations* (2014). A summary of the Regulations is presented in the *Element D* report.

## 5 EXISTING BUILDINGS

Existing buildings should not be connected to a DH network without first ensuring they are to a suitable level of compatibility and will not detriment individual operation or efficiency of the primary supply system. For example, if the accumulation of higher return temperatures is permitted this can lead to an overall return temperature above the minimum required for the operation of a CHP engine A lowering of the overall system temperature differential will also impact on the potential level of energy within in a thermal storage facility, the efficiency of the annual DH pumping regime and the DH pipe sizing / ability to provide further customers.

Many existing buildings have the legacy of the traditional approach to heating design with three-port control in particular being a significant problem on the constant temperature (CT) type systems. The system design temperatures are historically 82°C flow and 71°C return; however in reality, these temperatures are significantly higher than 71°C for the majority of the year due to the three-port by-pass arrangement. Even at peak times the temperature is higher based on the fact that a three-port solution is based on a balanced flow for the full connected load, when the actual peak has a significant level of diversity that is effectively being by-passed.

Most traditional existing building designs also incorporate weather compensated VT heating systems supplying radiators or other similar perimeter type circuits. With this type of circuit, the flow temperature is varied incrementally according to the external ambient temperature by three-port control blending the lower temperature return with the flow. These systems are more compatible with DH networks because they can provide lower return temperatures for a significant proportion of the year. They tend to operate on a constant flow basis, but more recently TRVs or zonal thermostat control has been introduced whereby flow is regulated and the pump can reduce in speed based on the change in the system differential pressure.

It is important, therefore, that potential new connections to existing buildings are properly assessed for their level of compatibility by determining which of the following they include:

- Constant temperature, variable volume circuits
- Constant temperature, constant volume circuits
- Variable temperature, constant volume circuits (weather compensated)
- Variable temperature, variable volume circuits (weather compensated)
- Centralised HWS supply
- Other system types
- Residential systems

Once the type of system(s) installed within a given connection has been determined, and prior to examining potential methods of enhancement where necessary, it is also beneficial to assess the existing operating performance by consulting trended temperature and energy data where available. If this information is not available or it is not possible to set up, then consideration should be given to a period of monitoring using portable temperature sensors and meters where appropriate.

Once the level of compatibility has been established, the areas where the operation may cause detriment to the DH operation need to be identified and enhancements reviewed in line with the potential solutions described in high level in the following sections. Note that many of these solutions may also make economic sense, regardless of whether the building is connecting to a DH scheme, based on heat loss and / or annual pumping savings. It should also be noted that these potential solutions only deal with enhancements that, although not optimum for DH connection, will ensure compatibility in a cost effective manner and without requiring total replacement of systems unless they were life expired (refer then to new system designs).

### 5.1 Constant Temperature (CT), variable volume

Where an existing building already operates a CT secondary system with two-port control and inverter driven pumps, this is generally an ideal connection for a DH network. Generally the approach on the older type building would be for a traditional 82°C / 71°C temperature operation, but some newer buildings may have incorporated a better design with lower returns or overall temperatures, for example 80°C / 60°C or even 70°C / 50°C. It would still be advisable to assess the existing operation to ensure the temperature parameters are in line with design requirements. Particularly for older buildings with the traditional approach to temperature, it would also be beneficial to consider whether the secondary / tertiary systems have been oversized, which is often the case, whereby there is potential to lower the operating temperatures without detriment to the operation. This can generally be assessed by reviewing control valve positions through the peak times (ideally trended from BMS) to see if they are ever required to be fully open. If not, it is possible that proportionally (ensuring suitable margins) the temperature of the system could be reduced i.e. it could be a 72°C / 61°C as opposed to the existing 82°C / 71°C. Another method is to gradually reduce the flow temperature set point during the winter months and assess what level it can be dropped to before any connections are compromised. Another investigation would be the number of pumps installed and any benefit both in rectifying any minimum flow by-pass for return temperature to the DH connection and in reducing annual building operation costs associated with pumping. The simple addition of a jockey pump to maintain the base loads for a large proportion of the year and allow turndown to minimum demand scenarios could have significant effect on pumping costs and ensure constant return temperature to the DH.

In short, although these are generally a suitable type of system for connection to a DH system, a review should still be carried out to confirm the potential for any enhancements that would further benefit the efficiency of both the building system and the DH operation.

### 5.2 Constant Temperature (CT), constant volume

As described above, this is the least compatible building secondary system configuration for a DH network connection as it produces fluctuating return temperatures based on the control of the heating demand. This is due to the traditional approach for CT circuits of utilising three-port control valves with a constant flow rate around the system, regardless of the demand. Again, the approach on the older type building would be for a traditional 82°C / 71°C temperature operation. As individual heating connections require less demand, the three-port control solution modulates to by-pass to provide a mix of flow and return temperatures. As stated, given no diversity control and a flow rate to suit the overall connected load, even at peak winter demand periods, there would be a large proportion of by-pass and the return temperature is very rarely seen close to the design 71°C. Over design/sizing of the overall circuit will only exacerbate this more. This type of system will use significantly more pumping power than the variable volume system and regardless of DH connection, modification would be recommended to reduce annual operating costs. The following enhancement and modification proposals focus on ensuring a connection to a DH system would be possible as opposed to the secondary system operation; however, they would all generally provide varying degrees of efficiency and thus operational cost savings. All, or a combination of them, would need to be assessed on a lifecycle basis to confirm viability. It is very rare that a constant volume circuit can be connected to a DH system without some form of detriment to the operation and therefore the following potential enhancements / modifications should be reviewed on an individual and cumulative basis to determine if there is a cost effective solution:

1) If the system is at, or very close to, end of life then there is commercial scope to replace the majority of pumping equipment and control components with a new solution in line with the optimum variable flow system described under Section 4.1 above. If wider replacement is possible, for example AHU upgrades, then a full review of design operating temperatures could also be considered.

2) A low cost, quick fix option is to evaluate whether there is suitable over design in the existing system for the potential to lower the operating temperature without detriment to the operation. This can generally be assessed by reviewing control valve positions through the peak times (ideally trended from BMS) to see if they are ever required to be fully open. If not, it is possible that proportionally (ensuring suitable margins) the temperature of the system could be reduced i.e. it could be a 72°C / 61°C as opposed to the existing 82°C / 71°C. Another method is to gradually reduce the flow temperature set point during the winter months and assess what level it can be dropped to before any connections are compromised. This would ensure that even with a three-port by-pass control operation the return temperature is unlikely to reach levels that could create serious issue for the DH supply. It would not provide any significant efficiency benefit to the building system, other than heat loss savings, although it could also be considered along with the more detailed modification potentials below.

3) Assessment of the overall payback on efficiency may confirm that it is viable to modify the existing three-port control arrangement to a variable volume two-port system, based on annual savings in pumping energy and this would provide the optimum solution for a DH connection. The modification of the three-port control devices at the system terminal units can be considered in one of two ways.

    i. Physically isolate the three-port by-pass, such that it operates as a two port as it closes to the load. Checks would need to be made to actuators to assess their differential pressure operating limits and these may need to be upgraded if necessary. Differential pressure control valves would also need to be installed across the system connections.

    ii. Change the three-port control valve at each connection with a replacement two-port control valve. Again, differential pressure control valves would also need to be installed across the system connections, although there is an alternative in the market where the control valve and DPCV are combined as a single device.

   Note that on both of these solutions the control at the terminal would remain as existing. The system pumps would also need to be checked for compatibility with maximum and minimum demand turndown with an inverter fitted if they do not already include for one, or full replacement of the pump sets with optimum variable speed selections. An easy win to provide minimum turndown efficiency, can be to consider the incorporation of a variable speed jockey pump to operate under a controlled regime with the modified larger existing pumps. Any modification to variable volume control would also require the inclusion of DP sensor control and minimum flow control for the pumps, along with dead leg control, all as described in Section 4.1 above.

Where multiple fan coil units are included within an existing CT circuit, it may not be cost effective to modify each individual unit and thus they may need to remain under a separately pumped constant volume regime, with careful assessment of what the final mixed return to the DH would be when combined with the rest of the circuit which has been modified to variable volume. If this is the case, then consideration should also be given to the incorporation of compensation on the FCU circuit to lower the operating temperatures for the vast majority of the year.

If CT circuits can be modified to two-port, variable volume control it is also worth investigating whether it is possible to widen the operating differential temperature, which will provide further efficiency benefits with regard to pumping on both the building and DH systems. This can be done by increasing the CT system flow temperature. For example, a standard AHU coil designed for 82°C / 71°C will have a mean temperature of 76.5°C. If you raise the flow temperature to say 85°C and maintain the mean temperature by reducing the flow rate, the return temperature from the coil will drop to 68°C with no detriment to the capacity. If the individual coil is over sized then there is scope to reduce the mean temperature and lower the return temperatures further. Under this regime it is generally best to install new two-port valves suitably sized for the reduced flow rate requirements.

Any works associated with the modification of equipment and components on existing constant volume circuits to provide the compatibility required with a DH connection can be extensive and thus it is imperative that detailed specification of requirements, along with full capital costing and payback analysis is carried out to ensure overall viability.

## 5.3 Variable Temperature (VT), Constant Volume

VT systems incorporate weather compensated control to change the set point of the system flow temperature based on the external ambient temperature. Older systems, again, are traditionally designed to operate at 82°C / 71°C at the peak external ambient temperature, with the 82°C reduced as the temperature rises. The older systems will rely fully on the compensation control to prevent over heating of the spaces and thus operate at a constant flow around the radiators or other perimeter type heat emitters. Some may include zonal shutdowns, or will have been retro fitted with TRVs at the heat emitters in which case they will operate more in line with the VT system type described in Section 5.4 below. Subject to the ideal balancing of the circuits, the operational differential temperature should generally stay constant through the annual demand profile and thus will reduce proportionally as the compensated flow set point is changed. For the vast majority of the year, this will therefore provide the potential for good return temperatures to a DH network.

To fully confirm the suitability for connection to a DH network, it is important to assess the operation of the various VT circuits and confirm that these return temperatures are suitable, particularly during peak external temperature periods. This can be done through analysis of existing trended data or through a period of remote temperature monitoring. If return temperatures are high then this can often be rectified by basic checks and re-commissioning of the system to ensure suitable balance across the circuits. Modifications for TRVs and zonal thermostatic control etc. will make the system more efficient for the building and more than likely provide better control for comfort; however, they are not critical in ensuring key compatibility with a DH system. The only enhancement that would optimise the operation further for connection to a DH system would be to reduce the operational compensated temperature settings. Many older buildings will have significant over design in these systems and could allow for significant reduction even at the peak winter periods, where even the peak setting of 82°C could be reduced to say 70°C or hopefully even lower. This can be done by gradually reducing the flow temperature set point during the winter months and confirming what level it can be dropped to before any circuits or areas are compromised.

### 5.4 Variable Temperature (VT), Variable Volume

The VT system with variable volume control is found in more modern installations, whereby there is a level of pump speed control based on the incorporation of zonal thermostatic isolations and / or the inclusion of TRVs at the circuit heat emitters. With regard to compatibility with a DH connection, this type of system would generally be identical to the more traditional VT system approach described in Section 5.3 above, with a similar approach to the potential enhancement options.

### 5.5 Centralised HWS Supply

The traditional approach for building HWS systems is for a centralised supply with cold feed and return circulation to a storage cylinder, which is either heated via a coil from the building CT heating circuit, or is direct fired unit. For the former, this would normally be supplied from a separate pumped circuit with a constant speed pump and three-port control. For the vast majority of the year these connections are normally in full by-pass and thus will provide a mix of full flow temperature back to the overall system return. This is obviously not the most compatible solution for a DH connection and also is not the most efficient for the building, based on annual pumping costs. With regard to the potential DH the first step is to analyse what the impact of this return temperature is on the overall and whether any modifications to the overall heating circuits (as described in the sections above) would make this negligible. If so it could be left as existing, otherwise, if demand against cost assessment proves viable, consideration should be given to one of the following enhancement / modification options:

1) Modify connection to a variable flow, two-port control arrangement, generally in line with the proposals described under Section 5.2 above. Note that consideration would need to be given to the prevention of dead head for the pump when two-port valve(s) are all closed.

2) Remove the three-port control and utilise a simple pump on and off regime to maintain the temperature in the storage cylinder, with suitable control temperature hysteresis to prevent cycling. The three-port control can be also be kept and modified to operate as an over temperature shut off.

3) If the cylinder coil(s) connections are suitably rated for temperature and pressure, the HWS interface can be modified to connect directly to the DH supply, with replacement of the three-port control with a two-port regime, complete with DPCV, as generally described under Section 5.2 above. Consideration should be given to incorporation of an over-temperature shut off regime, particularly if the DH temperature is significantly higher than the standard CT

system approach. This solution with a higher flow temperature will also lower the return temperature based on maintaining the mean coil temperature with a lower design flow rate.

4) Full replacement of the existing HWS connection with a packaged HWS substation supplied directly from the DH and connected to the existing cold feed, HWS flow and HWS return pipes. These can be the instantaneous type or include for a required level of storage as generally described under Section 4.1.5 above.

Where the building centralised HWS supply is from a direct fired cylinder, the only general approach in adding this demand to the DH connection would be to replace this in a similar manner to item 4 above.

Where the existing HWS provision is from point of use electrical units, it is unlikely that any introduction of a new centralised supply from a DH connection would prove viable.

## 5.6 Other System Types

### 5.6.1 Under Floor Heating

Under floor heating or other forms of lower temperature operation circuits are ideal for connection to a DH system and would generally require minimal assessment for compatibility other than the aspect of overall interface connection described in Section 5.8 below.

### 5.6.2 Radiant Panels

Radiant panels for warehouse type high level systems are normally operated with temperatures higher than a standard DH operation or even utilising steam. This makes them very difficult to consider for DH connection unless it could be proved that the existing could operate in line with the available DH temperature without detriment. The only alternative is to completely replace the panels with high level blowers with LTHW coils and two-port operation.

### 5.6.3 Direct Fired Units

Many warehouse type buildings also use direct fired blower units and again the only option here would be to replace these with a new LTHW circuit version similar to that described in Section 5.6.2 above.

## 5.7 Residential Systems

Existing residential systems will vary based on the type of dwelling, i.e. a block of flats or an individual house, or the type of systems providing the space heating and hot water to the residents. If this is from a communal system, such as many local authority systems still utilise, then DH connection would normally be from an interface at the central provision location, in which case it can be considered in line with any of the applicable requirements described under this Section 5. Full modification of this type of system to supply individual dwellings, could be considered if the existing pipework infrastructure was suitably life expired.

All individual dwellings that connect to a DH network would require a "wet" system on the dwelling side with a DH connection to the dwelling via an HIU as generally described in Section 3 above. If the existing dwelling system is a wet system, then the HIU can be installed in direct replacement of the existing boiler. The type of HIU would need to be considered based on how the dwelling circuit deals with the DHW. If there is a storage cylinder from the heating circuit, then this can remain as existing and the HIU will only require a heating circuit interface. If DHW was direct via a combination boiler, then this can be fully replaced with an HIU the also contains an interface for instantaneous DHW supply. Consideration can also be given to replacing the existing storage facility with an instantaneous supply from an HIU, although this would then require the adaptation of the cold and hot water pipework on the dwelling side. Existing "wet" dwelling heating circuits should be checked for their design operating temperatures and any areas where by-pass may raise the overall return temperature for example, a three-port control interface with a storage cylinder or the single radiator that is left to flow to prevent dead head of the pump. Good balance of a traditional dwelling radiator circuit, operating at the typical 82°C / 71°C temperatures, will be of benefit; however, ideally and in line with other system descriptions above, serious consideration should be given to a reduction of the operating temperatures. This is potentially possible purely based on the probable over design in existing systems and the off the shelf approach to radiator sizing, as well as the modern heat gains associated with electrical items now used. Where fabric modifications, such as double glazing, have been carried out over time, this would almost certainly provide the option to reduce temperature. Where the existing dwelling "wet" heating circuit is an underfloor type, this would generally be considered ideal and would require very little investigation other than the method of DH interface and the DHW requirements.

Where existing dwellings are electrically heated, which is still common in many local authority estates, particularly blocks of flats, the connection to a DH system would require the full installation of a new "wet" system within the dwelling and where applicable for blocks, the installation of DH pipework within risers and communal areas serving the individual flats. Although this provides the benefit of designing new optimum solutions to suit the DH, such as underfloor heating or low temperature radiator circuits (for example 60°C / 50°C), other practical considerations in line with the following can make this difficult:

1) Suitability for routing of the primary DH mains.

2) Suitability of the dwelling for the installation of a "wet" system.

3) Implications for heat gain from DH pipes within communal areas.

4) Disruption to all from the wider works.

5) Disruption to residents for the new system works within the individual dwellings.

### 5.8 DH Substation Interface Configuration

Individual building secondary systems can vary significantly on how they are configured with their existing boiler systems and therefore it is imperative that careful consideration is given to the interface connection points for the DH substation to ensure the most efficient solution is adopted. This can vary, not only based on the configuration of the building secondary system but also based on which of the following types of DH connection is proposed (note that the following options are all relevant for the connection of new build solutions as well as existing facilities):

1) Peak load connection – Under this arrangement the DH connection is designed to provide the full demand of the building throughout the year. The existing boilers would then either be made obsolete / removed, or would be retained in some form as back-up either under full auto control or by manual means.

2) Base load connection - Under this arrangement the DH connection is designed to control the demand up to an agreed base load level. If the load increases above this figure, then the existing boilers will be incorporated into the supply control to supplement the DH substation.

3) Load shedding connection - Under this arrangement the DH connection is designed to normally provide a base load; however, at peak times or for durations agreed under the heat supply agreement, the DH operator can shut down the substation, at which time the existing boilers would be required to meet the building demand.

4) Supplemental connection – This would only be the case generally when the building already has its own base load low carbon supply which would take precedence over the DH supply, for example a biomass boiler or heat pump. Under this operation the DH substation would only supply heat when the demand rose above the output of this base load supply or if this supply was unavailable. The DH connection under this regime may not be sized to cover full peak demand and thus the existing building gas fired boilers may also be required in the overall control regime to provide supplement or standby.

5) Off peak supply connection – This generally involves the DH connection providing heat outside of normal peak times to assist in smoothing the demand profile of the overall DH system. This would be carried out with the use of thermal storage at the building connection, which is charged by the DH connection and then discharged at the peak times. The final solution as to how thermal storage would be incorporated into a building DH interface is subject to the building heat profile, along with the decision as to whether it will provide the full heating requirements or a specific proportion, whereby it would be supplemented by local boiler plant. The capacity of the required thermal storage would then be developed in line with this, which then leads to the other significant factors relating to spatial allowance and structural integrity, particularly at existing locations. The thermal storage facility can be incorporated on either the primary or secondary side of the interface, although with the primary system normally operating with wider operating differential temperature, this will provide the ability to store a proportionally increased level of energy for the same volume. The interfacing and control can have varying levels of complexity based on the proposed solution; however, if local use of boilers is proposed to supplement the DH connection and thermal store, then a controls link to the primary DH facility is essential to ensure that the connection only charges the thermal store with heat generated by the low carbon plant.

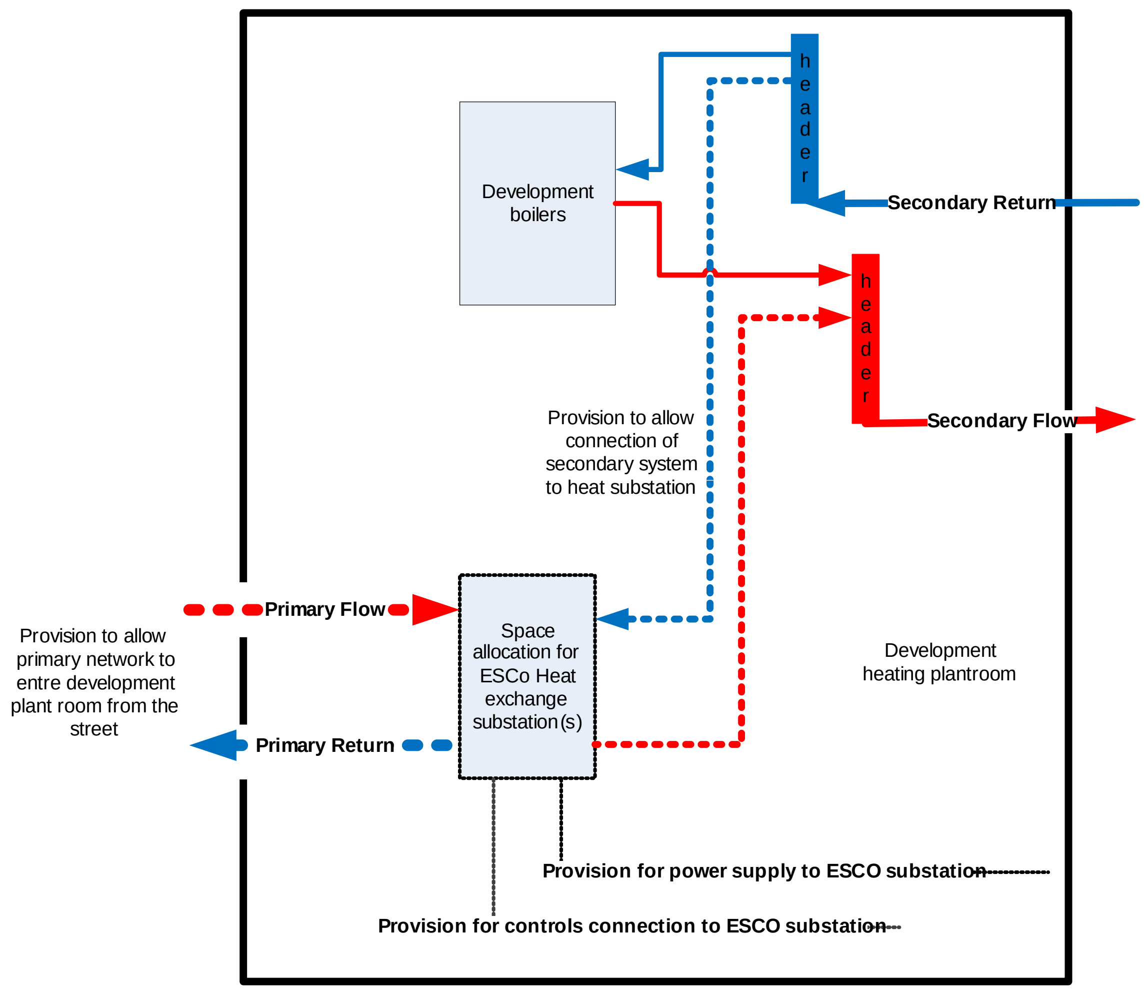
Final connection arrangement would need to be confirmed once all of the above has been established.

## 6 PHYSICAL REQUIREMENT FOR INCORPORATING THE DH SUBSTATION

### 6.1 Provision for future connection of DH substation

The sketch below illustrates the requirement for providing:

a) A means of bringing the primary heating mains into the development or building plantroom from the street.
b) Space allocation for the heat exchange substations in the development heating plantroom.
c) Provision for the physical interface between the DH heating substation and the development heating system.
d) Provision for mains power supply for the DH substation.
e) Provision for a controls interface with the building heating systems and the DH substation.
f) As described in Section 5.8 above, there is potential to incorporate thermal storage at the customer interface; however, subject to operational requirements and the final design solutions to suit, this can be incorporated in a number of ways and is thus not included within the following sketch.



## 6.2 Plant layouts

DH substations should be supplied as single packaged units to suit the required demands. Depending on the level of demand, the units may consist of more than one heat exchanger up to as many as three exchangers for larger loads. The following table provides indicative spacing requirements, based on a single supplier assessment, for a number of standard heating loads:

| ESCo District Heating Substation (primary:/ secondary interface) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Output (kW) | 250 | 500 | 800 | 1,000 | 1,500 | 2,000 | 3,000 |
| Number of Heat Exchangers | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| Length (mm) | 1,500 | 2,250 | 2,250 | 2,750 | 2,750 | 3,000 | 3,000 |
| Width (mm) | 500 | 750 | 750 | 1,500 | 1,500 | 1,500 | 1,500 |
| Height (mm) | 2,000 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 | 2,500 |
| Approximate Dry Weight (kg) | 725 | 1,050 | 1,300 | 1,725 | 1,800 | 1,925 | 2,000 |

The following should be noted regarding the above dimensional data:

- As stated, these are provisional sizes and should therefore be updated during the design and procurement process, when full supplier data and drawings can be provided.
- The figures indicated are the packaged skid dimensions only and therefore an allowance of 1m should be incorporated all around the skid to facilitate access and maintenance requirements.
- The larger packages with more than one exchanger may provide difficulty in delivery and building access, therefore, it is envisaged that the skids could be broken down into sections based on the number of exchangers. This should be clearly indicated on supplier details.
- Note that should thermal storage be recommended as part of the DH interface, suitable space allocation will need to be provided, along with structural analysis for the potential significant associated weight.

## 6.3 Minimum Plant Room Equipment Requirements

The following describes the typical requirements at the building plant areas where the substations are to be located. Ideally this will consist of a lockable independent plant room; however, incorporation within general plant areas is possible although suitable procedures on demarcations would need to be established. The following table provides a list of requirements, although it should be noted that if the connection is located in a shared general plant room then some of the items may be covered under the provision for the overall plant area.

| ITEM | SPECIFICATION REQUIREMENT |
|---|---|
| ROOM ILLUMINATION | Minimum light level: 150 lux. |
| ELECTRICAL CONNECTION (for maintenance) | III 380 V to earth / 32 A[5]. |
| ELECTRICAL SUPPLY (Control box) | 220 V AC (+/- 5%)<br>50 Hz (+/- 3%)<br>Thermo-magnetic protection recommended 16 A curve C (the box incorporates a thermo-magnetic protection of 10 A curve C in the supply). |
| WATER SUPPLY | DN 25. |
| WATER DISCHARGE | Provide wastewater discharge line in the plant room and a sump to collect condensation from heat exchangers. |
| CONCRETE STANDS | Provide concrete stands for heat exchangers and pumps (if present). |
| VENTILATION | Mechanical and continuous, with a minimum of three air changes per hour. |
| HEALTH & SAFETY | Plan showing evacuation route in case of fire, located in a visible place.<br>The plant room should not have elements of risk to health and safety (sharp metallic objects, holes in roof or floor without protection, …) |
| LAYOUT & DIMENSIONS | As described for the relevant packaged substation unit. |

[5] If an electrical connection is available in a general plant area, it is assumed that access would be provided during any maintenance works. It is not considered that an outlet would be provided where an individual substation plant room is proposed. In such cases it would be envisaged that the nearest available point would be made available following co-ordination with the individual building operator.