



Brixton Heat Network Viability Assessment

Date 24/10/2019

Document Verification

Project Title	Lambeth Heat Network Opportunities			Job Number	265933
Report Title	Brixton Heat Network Viability Assessment			File Reference	
Revision	Date		Prepared By	Checked By	Approved By
Draft 1	01/10/2019	Name	CC, FP	AL	TTB
		Signature			
Final	24/10/2019	Name	CC, FP	AL	TTB
		Signature			

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Glossary of terms

Table 1: Glossary of abbreviations used throughout this report

Abbreviation	Full name
ASHP	Air Source Heat Pump
BEES	Building Energy Efficiency Standard
BSRIA	Building Services Research and Information Association
CAPEX	Capital Expenditure
CHP	Combined Heat and Power
CIBSE	Chartered Institute of Building Services Engineers
COP	Coefficient of Performance
DH	District Heating
EC	Energy Centre
GIA	Gross Internal Area

Abbreviation	Full name
GSHP	Ground Source Heat Pump
GWh, MWh, kWh	Gigawatt-hour (units of electrical or thermal energy)
HNIP	Heat Networks Investment Programme
IRR	Internal Rate of Return
NOx	Nitrogen oxides
SCOP	Seasonal Coefficient of Performance
OPEX	Operational Expenditure
PW	Private Wire
REPEX	Replacement Expenditure
WSHP	Water Source Heat Pump

Executive Summary

Executive summary

This study has investigated the implications of implementing district heating in Brixton, serving planned new developments and the Brixton Recreational Centre. London Plan Policy puts district heating at the top of the Heating Hierarchy, meaning referable planning applications (like these ones are) would be expected to either connect to an existing network or show building inter-connectivity.

Buildings were grouped into 4 key clusters (where colours are denoted in Figure 0.1): planned developments on council owned plots (blue), the existing Brixton Recreational Centre (green), privately owned Town Centre plots (yellow) and the Homes for Lambeth Somerleyton Road development (red).

Four building inter-connection scenarios were modelled, using the blue plots as the anchor load and extending the network from there. The full network extent as depicted in Figure 0.1 has an estimated peak heat demand of 4.7MW and annual consumption of 4.5GWh. These are based on benchmarks and could be reduced through efficient building design.

For each connection scenario, four technology solutions were modelled:

- gas boilers and gas CHP,
- air source heat pump and gas boilers, ground source heat pump and gas boilers, and
- an all electric solution of air and ground source heat pumps.

Results of the network scenarios were compared to the likely alternative solution (the 'counterfactual') that would be pursued by developers in order to secure planning permission and meet building regulations, which was assumed to be individual building air source heat pumps.

Many network solutions were estimated to compete on capital cost with the counterfactual. Across all scenarios the ASHP and gas boiler solution has the lowest capital cost (CAPEX). The hybrid network solutions are eligible for Heat Network Investment Projects (HNIP) capital grants, but the impact of this has not been modelled.

All the hybrid fuel networks (ASHP/GSHP with gas boilers) perform better financially than the counterfactual. This is because heat generation costs are lower than the counterfactual due to gas meeting demand when heat pump efficiencies are lowest.

Connection of Somerleyton Road does offer performance improvements over the counterfactual, and provides an opportunity to pursue a lower carbon heating strategy than the CHP currently proposed. The pipework length joining the site to the other developments runs along the busy Coldharbour Lane; this route needs further viability assessment.

The counterfactual building-by-building ASHP requires a significant amount of roof space for the energy plant on each building. In some instances, such as in the developments

under the railway arches, this may prove difficult. In contrast, district heating schemes can deliver the required heat using up to 50% less space overall. A high level study has shown that this could be housed on a singular council owned plot in the city centre or in Somerleyton Road. This would allow for the other rooftop space to be used for other amenities or solar PV, should the development be required to reduce carbon emissions further.

District heating options with gas boilers have higher carbon emissions than the counterfactual. Electric backup boilers were not investigated, but could offer good compromise for capital cost and space requirements in comparison to the full ASHP/GSHP network solution. Operating costs will be higher than the counterfactual, making this solution higher cost for consumers. It would also increase the electrical grid connection capacity requirement, introducing further risk to network implementation.

For a network to be viable, early communication with developers is vital, helping ensure their buildings' heating systems are designed in a way that is compatible with the network. Further investigation of the following key points would give greater certainty on viability:

- Whether electric backup boilers could be a viable alternative to gas boilers. This requires:

- Modelling financial performance; and
- Understanding the implications of higher capacity grid connection;
- Technical viability of the proposed connection route between Somerleyton Road and the Town Centre;
- Include development phasing plans in the modelling;
- Further refine the space requirements of the proposed scheme; and
- Engage with Somerleyton Road developer to understand implications of using/ hosting different heat generation technology than the proposed CHP.

In final conclusion, a heat network in Brixton could save carbon and be financial viable, as well as saving considerable space for developers.



Figure 0.1 Proposed network

1. Introduction

1.1 Introduction

Arup was commissioned by Lambeth Council to carry out a high-level feasibility study of district heating (DH) in Brixton town centre.

District heating is a method of distributing heat, from an energy centre or centres to residential and commercial customers for space and water heating.

District heating can enable heating decarbonisation through the integration of low carbon technologies, which would otherwise not be economic or practical. By aggregating heat requirements of various buildings, district heating offers benefits in terms of overall plant sizing, 'waste heat' use, energy storage, supply technology flexibility and capital costs compared to a building-by-building approach.

Now, with Lambeth council's announcement of a climate emergency and pledge to reduce carbon emissions to net zero by 2030, alongside the high level of planned development in the area, it is an opportune time to assess the potential of a DH network. The Greater London Authorities (GLA's) heating hierarchy recommends connection to a district heating network as a priority for new developments.

Study Area

Brixton town centre is a densely populated area with a well-used market behind the station. The developments in this study lie

within this area and at Somerleyton road. There is significant rail and road infrastructure immediately adjacent to the sites, making construction very challenging. Furthermore, installation of pipework will have to be coordinated through rail underpasses, adding further risk.

The buildings have been divided into four clusters based on their ownership/planning status.

Our Approach

The key heat demand clusters are the Brixton recreation centre, Plots 1, 2A & 2B, plots 3, 4 & 5 and the Somerleyton road development, as shown in Figure 1.

An assessment of potential supply options was carried out, considering the suitability of various heat (and power) generating technologies which could serve the DH scheme.

Economic and carbon analysis was conducted to compare the scenarios against an agreed counterfactual of building-by-building air source heat pumps (ASHPs). ASHPs have been chosen as the counterfactual technology to be in alignment with the draft New London Plan and Part L of the Building Regulations.

Potential energy centre locations are identified and the merits of each considered as part of this study.

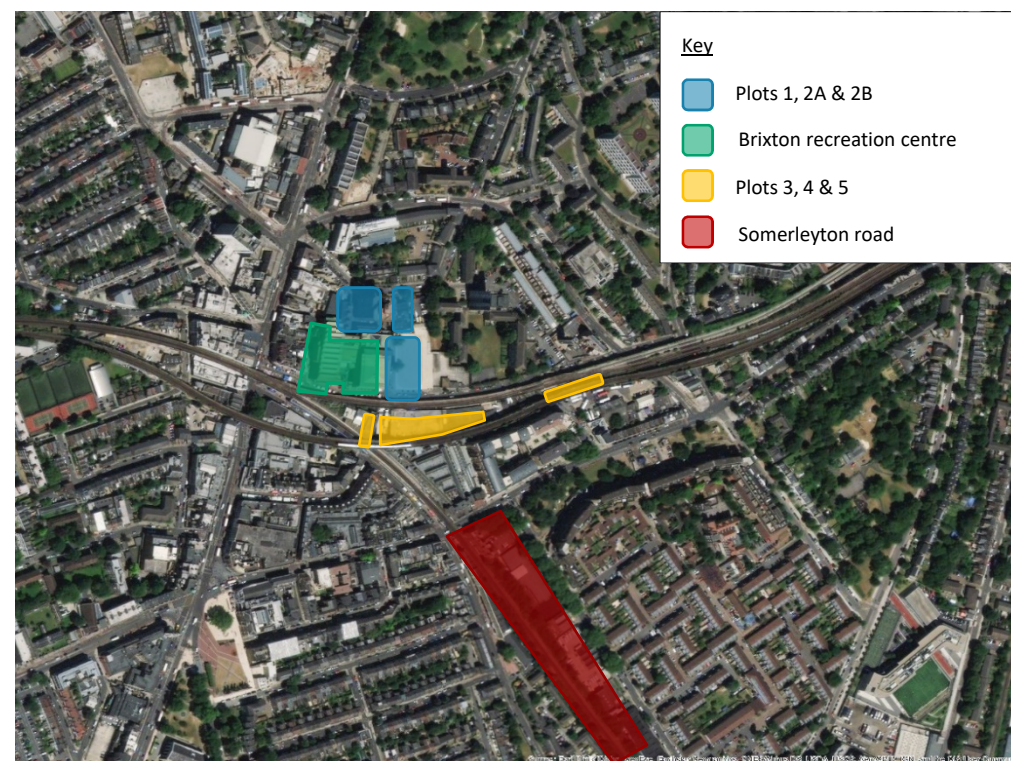


Figure 1.1 Study area map

2. Connection scenarios

2. Connection scenarios

2.1 Introduction

Heat load assessment

A demand and consumption assessment was carried out to estimate the building's heating loads. For planned developments this was based on the Building Energy Efficiency Standard (BEES) benchmarks for annual heat requirements, and Building Services Research and Information Association (BSRIA) rule of thumb for peak heat demand. High-level diversity factors between 70-90% were assumed depending on the level of building inter-connectivity. For the Brixton recreation centre, annual heat requirements were obtained from the WSP report.

Connection Scenarios

Different scenarios for connecting buildings to a network have been tested as part of this study as follows:

- Plots 1, 2A & 2B only;
- Plots 1, 2A, 2B, 3, 4 & 5;
- Plots 1 – 5 & the Recreation Centre;
- Plots 1 – 5, the Recreation Centre and Somerleyton road.

Plots 1, 2A & 2B

These council owned buildings make up the anchor loads of the district heating scheme and as such are included in all scenarios. Plots consist of 207 dwellings and 9,500m² office/retail space.

Plots 3, 4 & 5

Plots 3, 4 & 5 are situated between two over ground railway lines. Parcel 3A has a gross internal area (GIA) of c. 7,000m² of work/retail space; the others have a combined retail space of c. 8,000m². The location of the these plots will make the pipework and routing of the district heating network more challenging.

Recreation Centre

The recent WSP report proposes various future scenarios for this existing space including provision of work space, refurbishment of the leisure centre and building a new leisure centre. The indicative plan for the space has a GIA of 1105m². The Recreation Centre has recently replaced their gas boilers but have a shortfall of 36% of their energy demand. In this study we anticipate that the recreation centre will continue to use these boilers for the remainder of their lifetime and connect to the network to provide baseload heating.

Somerleyton Road

The redevelopment of Somerleyton road is south of the rest of the network. It is proposed to provide c.300 residential units with a further c. 9,000m² of non-residential space, split over 6 blocks. Somerleyton road would require 210m of additional pipework to connect. scenario.

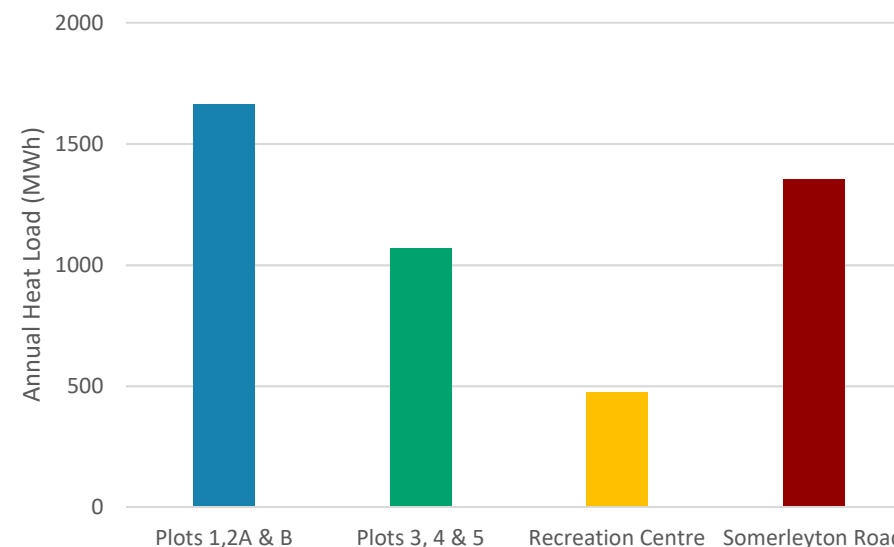
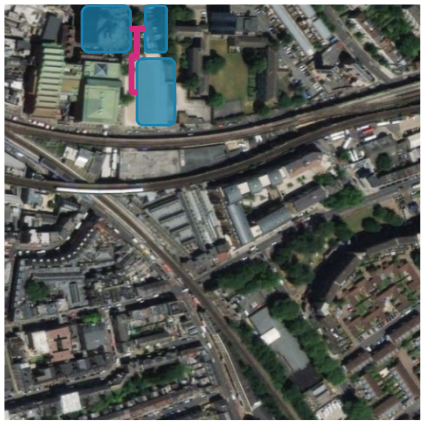
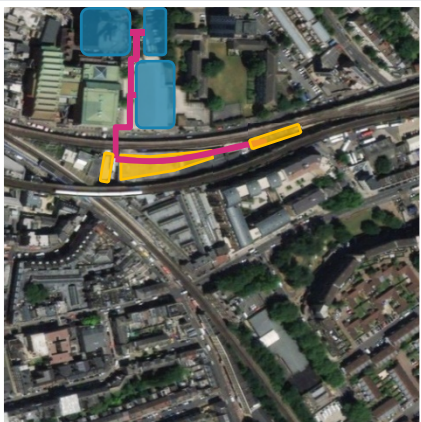


Figure 2.1 Heat load summary

2. Connection scenarios

2.2 Modelled scenarios and associated network routing

Table 2.1 Summary of the four connection scenarios

Scenario no.	1	2	3	4
Clusters included	Plots 1, 2A & 2B	Plots 1, 2A, 2B 3, 4 & 5	Plots 1, 2A, 2B, 3, 4 & 5 and recreation centre	Plots 1, 2A, 2B, 3, 4 & 5, recreation centre and Somerleyton Road
				
Indicative Heat consumption (GWh)	1.7	2.7	3.2	4.5
Indicative Peak demand (MW)	1.3	2.5	3.8	4.7
Network length (m)	90	340	350	560

3. Supply technologies

3. Supply technologies

3.1 Introduction

Heat supply technologies

For this study Arup has considered various heat sources and have assessed them based on their economic and carbon performance whilst also considering their capacity, practicability and availability in Brixton.

Typically district heating networks include both baseload and peaking plant. The baseload technology provides the majority of the annual heat load and is generally operational all year round and should therefore be low carbon. Peaking plant is sized to supply during times of peak demand and will typically run for a shorter duration throughout the year (mainly in the winter), and may not be low carbon.

Gas-fired CHP

Gas-fired Combined Heat & Power (CHP) generates electricity and heat from combustion of gas. Revenues from electricity production are typically maximised by operating the CHP as a baseload technology.

Before significant UK grid decarbonisation, CHP offered carbon emission savings by offsetting power that may have otherwise been generated by coal.

With increased renewable electricity penetration, CHP is no longer viewed as a low carbon technology. Due to updates to the SAP carbon emissions factors, CHP will no longer provide the carbon emission savings

required to secure planning permission when assessing a development proposal under Part L of the Building Regulations. In addition to this, CHP has poor air quality implications.

Until recently, CHP was the business as usual technology for new developments in London. As such, it has been included in this assessment to illustrate the implications of electrically derived heating.

Gas boilers

Gas boilers are a low cost, low space technology, often used as peaking plant in district heating (due to their high carbon emissions per unit heat output). They are typically used alongside a lower carbon baseload.

Whilst NOx emissions are lower per unit heat than CHP engines, care must be taken around air quality implications. This can be achieved through the use of ultra-low NOx gas boilers; flue gasses must be vented to atmosphere at an appropriate height above surrounding buildings.

Ground Source Heat Pumps

Ground source heat pumps (GSHPs) harness low grade heat from the ground, using electricity to raise the heat to useful temperatures. A well designed system may be able to provide 4 units of heat for every one unit of electricity consumed.

'Closed-loop' systems incorporate sub-surface heat exchangers that can recover heat from or reject heat to the ground. This system is well suited to applications where there are balanced heating and cooling demands over the year, such that the net ground load is as close to zero as possible over the year.

Open loop systems extract water from an aquifer or water body at one location and reinject it in another. Due to the load profile of development in Brixton, and space constraints in the area, it is thought open-loop is more viable. The Environment Agency GSHP screening tool indicates that 50-100m deep boreholes would be required to reach the London aquifer. High level temperature and flow yield assumptions have been made to assess this technology currently.

Air source heat pumps

Air source heat pumps (ASHPs) harness energy from the ambient atmosphere. Inherent lower air temperatures than those found underground make ASHPs less efficient than GSHPs.

Due to their cost, space requirements and associated carbon emissions for the provision of heat, ASHPs are increasingly becoming the go-to heating technology for new developments.

They require access to ambient air and as

such are commonplace on the roofs of buildings or in an outdoor compound. Where large banks of ASHPs are installed, care must be taken around formation of ice on and under evaporator coils, noise and the potential for provoking a 'coolth-island' effect, i.e. large volumes of cold air.

However, ASHPs have the advantage that they can be utilised whenever external/roof space is available, and are not resource and location dependant like GSHPs and surface water heat pumps. In addition, ASHPs are generally a well-established technology, with lower costs and complexities compared to GSHPs or surface water heat pumps.

Waste heat from the London Underground ventilation shafts

Through a separate study being undertaken by Arup for TfL, a London Underground ventilation shaft was identified on the site of the Somerleyton Road development. Due to elevated temperatures on the London Underground (LU) network, heat recovery from the air flow there could offer high heat pump efficiencies.

However, following further investigation as part of that study, it has been found that for various reasons heat recovery at that location would be particularly difficult and not yield enough energy to make the system worthwhile installing.

3. Supply technologies

3.2 Summary of four technology scenarios

Table 3.1 Summary of four technology scenarios

Scenario	Technology Scenario	Ambition level	Baseload technology	Peaking technology	Considerations
A	Traditional	Low	Gas-fired CHP	Gas boiler	- Carbon intensive technology - May be difficult to comply with planning policy - Poor air quality implications - Electricity is assumed to be exported to grid, sold at c. 50% of the retail price
B	Hybrid ASHP	Medium	ASHP	Gas boiler	- Diverse fuel supplies means an increased reliance against fluctuations in fuel prices. - The gas boiler peaking plant mitigates against the risk of ice build up during coldest days (i.e. in the case of ASHP peaking plant). - Lower efficiency than ground or water source heat pumps.
C	Hybrid GSHP	Medium	Open-loop GSHP	Gas boiler	- Higher efficiency than air source heat pumps. - Preliminary investigations suggest open loop technology may be viable at this locations - Minimum 100m spacing required between extraction and injection wells - Diverse fuel supplies means an increased reliance against fluctuations in fuel prices. - Amount of heat that can be extracted from the aquifer is heavily reliant on the aquifer flow and water table height at the location. There are inherent risks with predicting this and it is likely a test borehole would be needed to confirm potential.
D	All Electric	High	Open-loop GSHP	ASHP	- See also above - Lowest carbon solution - Greatest space requirement - No on-site combustion, with benefits in terms of local air quality. - Potential to achieve zero-carbon heat supply through the use of renewable electricity. - Lower resilience as it is reliant on only one energy vector. - Risks around ice build-up. This can be mitigated against in early design stages. - Lowest heat pump efficiency, therefore highest cost

4. Modelled scenarios

4. Modelled scenarios

4.1 Summary of 16 modelled scenarios

Scenarios

16 scenarios have been modelled to assess the impact of the supply technology and the extent of building inter-connectivity. A summary of the technology supply assumptions used is described below.

Traditional scenario

This scenario assumes CHP to supply 75% of the heat consumption and the gas boiler to supply the remaining 25%. In this scenario the gas boiler supplies 80% of the peak demand. This is in line with requirements of HNIP funding, a £320m UK Government fund for heat network capital.

Hybrid ASHP

This scenario assumes the ASHP 60% of the heat demand and the gas boiler to supply the remaining 40%. In this scenario the gas boiler supplies 80% of the peak.

Hybrid GSHP

A high level geological survey has been conducted for the proposed Ground source heat pumps (GSHPs). Assuming a temperature differential of 5°C and an extraction rate of 10l/s a singular well could produce 200kW. This means that depending on the size of the network the GSHP can supply between 70-30% of the heat demand and between 22-6% of the peak. The remaining demand would be met by the gas boiler.

For an open-loop GSHP an indicative distance of 150m is required between flow and extract points. This may be achievable within Plots 1 2A & B, although further research is required.

It is assumed wells cannot be drilled between railway lines due to difficulties of accessing area with a drilling rig, and complications around Network Rail.

All electric

The all electric scenario assumes the same GSHP constraints but uses air source heat pumps (ASHPs) to supply the remaining supply and peak load.

There are risks around the assumption that ASHPs can be used to provide peak demand, as when temperatures drop, heat pump output capacity falls too. Whilst there are examples in Denmark, it is not common in the UK. Below about 6°C, defrost cycles have to be used to prevent freeze up of evaporators. This further reduces efficiency. Urban 'coolth' island effects are also a risk, whereby cool air produced by the evaporators sits around at ground level.

Designing an all-electric heat pump solution would require very low network temperatures in order to raise efficiencies. This has not been modelled here.

Table 4.1 Summary modelled technologies and plant capacities

Scenarios: Connection → Technology ↓	1	2	3	4
A	CHP: 240kWth Boiler: 1.1MW	CHP: 440kWth Boiler: 2.1MW	CHP: 610kWth Boiler: 2.9MW	CHP: 720kWth Boiler: 3.4MW
B	ASHP: 240kWth Boiler: 1.1MW	ASHP: 440kWth Boiler: 2.1MW	ASHP: 610kWth Boiler: 2.9MW	ASHP: 720kWth Boiler: 3.4MW
C	GSHP: 260kW Boiler: 1.1MW	GSHP: 240kW Boiler: 2.4MW	GSHP: 210kW Boiler: 3.4MW	GSHP: 220kW Boiler: 4.0MW
D	GSHP: 260kW ASHP: 1.1MW	GSHP: 240kW ASHP: 2.4MW	GSHP: 210kW ASHP: 3.4MW	GSHP: 220kW ASHP: 4.0MW

5. Techno-economic analysis

5. Techno-economic analysis

5.1 Capital cost

Capital cost

The capital cost (CAPEX) of the project is made up of the connection costs, plant capital costs, pipework costs and the costs for the energy centre, space and utility connections. The techno-economic modelling has revealed the following conclusions about the CAPEX of the proposed networks.

- As would be expected, the CAPEX of the projects increases with the size of the scheme connected. This is due to the longer network pipe lengths as well as the increased plant capacities.
- Across all of the connection scenarios the air source heat pump (ASHP) and gas boiler solution has the lowest CAPEX. The major contributing factor to this is the comparatively cheaper plant capital cost of the ASHP to the Ground source heat pumps (GSHPs) and CHP.
- Across all of the scenarios the all electric GSHP / ASHP solution has the highest CAPEX. This is primarily due to the ASHP being relied on to provide peaking heat demand rather than the significantly cheaper gas boiler. An alternative all-electric solution is to use electric **backup** boilers. Whilst these are cheap and take less space, they are very expensive to operate. The cost to the occupant could be mitigated by installed on-site renewables such as PV panels.
- Grants from HNIP for up to 50% of the capex are for between £0 and £5million for projects that supply 75% of heat from CHP or 50% of their heat from renewable sources. Whilst CHP and hybrid ASHP and all-electric scenarios meet this requirement, GSHP scenarios 2,3,4D do not.
- It should be noted that this cost represents the capital expenditure only and does not capture the operational costs or costs associated with carbon offsetting.
- A 50% optimism bias has been allowed for in the CAPEX assumptions to adjust for the high level nature of this study.

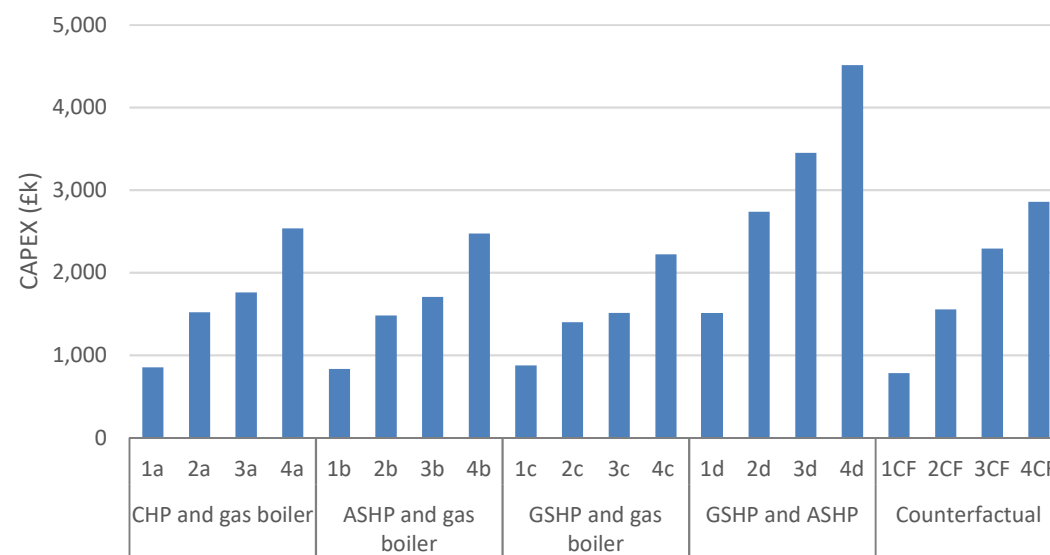


Figure 5.1 CAPEX of each scenario

5. Techno-economic analysis

5.2 Economic analysis

Impact of the counterfactual

Traditionally, a dwelling by dwelling gas boiler solution would be assumed for the counterfactual heat network. However in alignment with the draft New London Plan and Part L of the Building Regulations, a counterfactual of building by building ASHP have been used for this assessment. This assumes a partially centralised system in which roof space and an energy centre would be required in each building.

The IRR values presented in this report are as a comparator to the counterfactual, and do not represent a true project IRR.

Assumptions for the capital cost (CAPEX), operational cost (OPEX) and replacement cost (REPEX) values of the counterfactual case were used to derive the counterfactual variable price of heat based on the heat delivered under each scenario, found to be around £0.13/kWh. This price of heat was then adopted in the district heating scenarios, with financial performance being compared to the building-by-building ASHP counterfactual.

All of the results should be viewed as a comparative to the counterfactual and as indicative predictions of the financial performance of the schemes only.

Economic results

The high-level techno-economic modelling has identified the following conclusions about

the proposed networks in comparison to the counterfactual:

- Hybrid fuel networks (ASHP.GSHP & boilers) give a higher return than the counterfactual over 40 years;
- Network economic performance increases with the connection of plots 3, 4, 5 and the Brixton Recreational Centre; district heating typically benefits from economies of scale. Additionally, more connections brings greater diversity to peak load, reducing the overall network peak and lowering plant requirements (CIBSE CP1);
- Economic performance decreases with the addition of the Somerleyton Road development due to the relatively long pipework length in comparison to connected heat load;
- Ground source heat pump (GSHP) scenarios perform better than air source heat pump (ASHP) scenarios due to higher Coefficient of Performance (COP). There are higher risks associated with this system as the heat output can only be confirmed after drill testing;
- The 'all electric' scenarios perform poorly due to the high CAPEX and OPEX of using ASHPs as peaking plant;
- Private wire electricity export from CHP is not included but would improve the economic case for scenario 1 - 4.

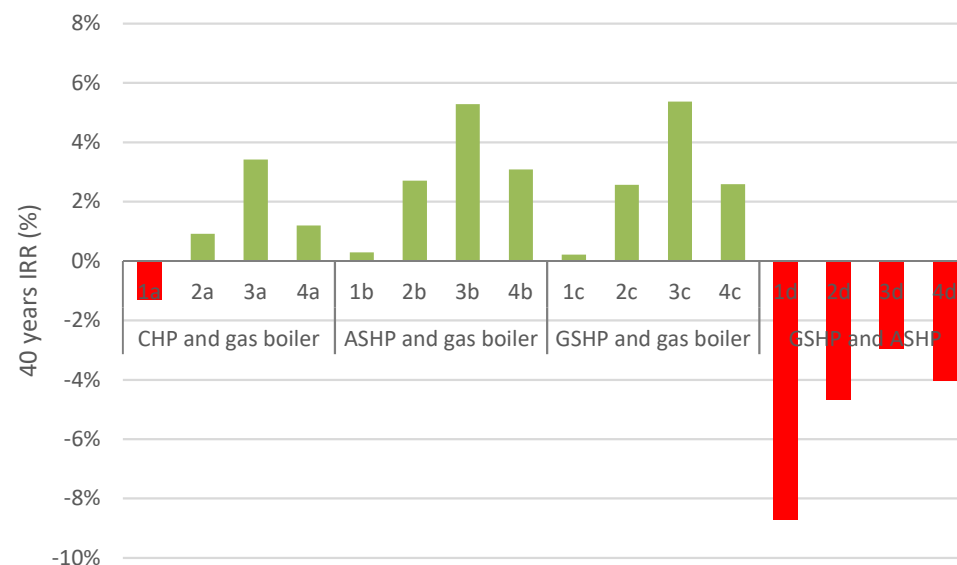


Figure 5.2 40 years comparator IRR of each scenario compared to the counterfactual (not actual project IRR)

5. Techno-economic analysis

5.3 Carbon emission assessment

Part L of the Building Regulations requires developers to show how a 35% reduction in carbon emissions against a 'notional' building will be met. This is achieved in many ways, largely through energy efficiency measures and the use of low-carbon or renewable energy sources.

Known as the 'Standard Assessment Procedure' (SAP), carbon emissions are calculated with published factors for various fuels. In London, the draft New London Plan requires new buildings to estimate their energy consumption using the latest SAP 10 carbon emissions factors. These figures favour electric solutions more than the previous SAP figures. Furthermore, in London, developments are required to contribute to an offset fund in order to be 'net zero carbon'. The amount paid is relative to the emissions remaining post Part L assessment and in Lambeth is equal to £60/tonne over 30 years, payable in year 1. This has significantly increased the value of low carbon solutions in London.

The counterfactual chosen in this study (a building by building ASHP solution) represents an ambitious, all-electric and low carbon solution, as shown by the blue line in Figure 5.3. Solutions shown here with gas peaking plant give higher carbon emissions than the counterfactual, and therefore will be subject to higher carbon offset payments (this

is accounted for in our model).

The 'notional' building calculation assumes a gas boiler for the baseline carbon calculations, as shown by the red line in Figure 5.3, calculated over a 40yr period.

The district heating solutions modelled here all emit more carbon than the ASHP building-by-building counterfactual. Hybrid and all electric HP solutions emit less carbon than the 'notional' building baseline, but when CHP is in the mix, it does not.

Meeting planning policy and Building Regulation requirements can be achieved in many ways other than just through low carbon heating solutions; scenarios that emit more carbon than the counterfactual could avoid higher offset payments through implementation of other interventions such as higher energy efficiency measures or installation of solar PV.

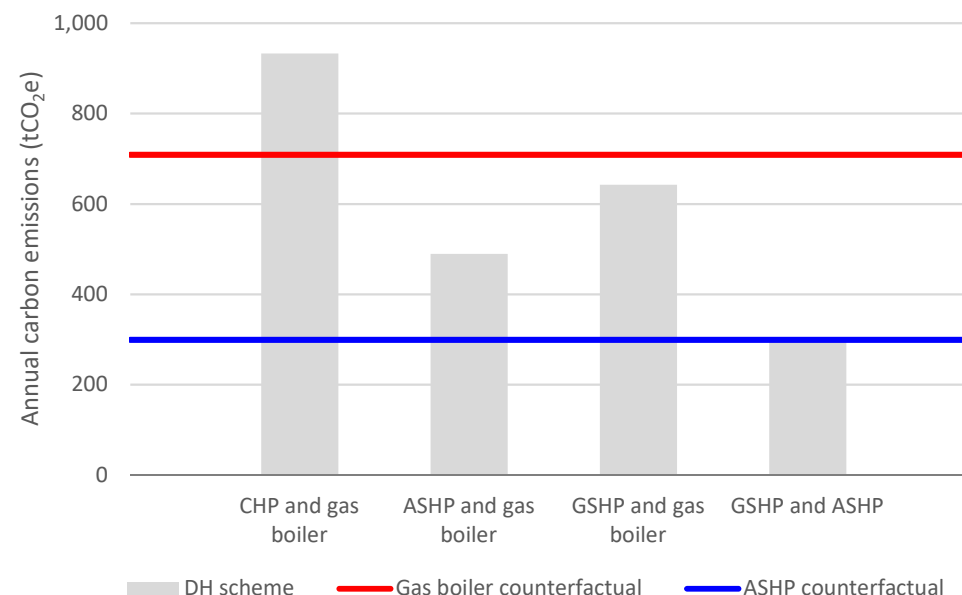


Figure 5.3 Annual carbon emissions for scenario with Plots 1, 2A, 2B, 3, 4, 5 and the Recreation Centre

6. Energy Centre Locations

6 Energy Centre Location

6.1 Space requirements

Counterfactual space take

The counterfactual space take far exceeds that of any of the DH network solutions. The space required is approximately double that of the largest DH network energy centre.

Figure 6.2 shows the percentage of its roof space each building would need to reserve for plant space for the ASHP counterfactual.

This shows that it is possible for all buildings to host the counterfactual ASHP solution but that it would take up significant amount of valuable roof space that could not then be used for PV or other uses such as terraces or green roofs.

Space requirements

The space requirement of the energy centre for each scenario has been calculated based on high-level industry standards and is inclusive of ancillary equipment.

External space is required in some scenarios for the evaporators of the air source heat pumps (ASHPs), and internal space is required for other plant items such as boilers, CHPs and heat pump units.

This analysis reflects on if the central plant of the DH network could be housed in either the recreation centre or in one of the council owned developments, plots 1 2A & B.

The recreation centre has a 200m² basement space that could be available for an energy

plant (Buro Happold Report – Brixton WP2/3, Detailed Feasibility Report, p38). The external roof space of the Brixton recreation centre is 178m². The actual available space should be confirmed in a more detailed feasibility study.

The largest of the council owned planned developments is parcel 2A with a ground floor internal area of c.2,500m² and an assumed available external roof space of 400m².

Figure 6.1 shows in green all of the scenarios that are possible given the space restrictions of each building. The scenarios in red show when the required space is not available on a single building.

For all the CHP and Ground source heat pump (GSHP) scenarios both the recreation centre or council building have sufficient internal space for the energy centre.

In scenarios using the ASHP as a baseload with peaking gas boilers the council owned building is the only building with sufficient roof space.

In the all-electric scenarios the space requirement of the ASHP in the three larger networks is too large for any single building to house the energy centre. This could be reduced through the use of electric backup boilers, but the operational costs of this system would be particularly high.

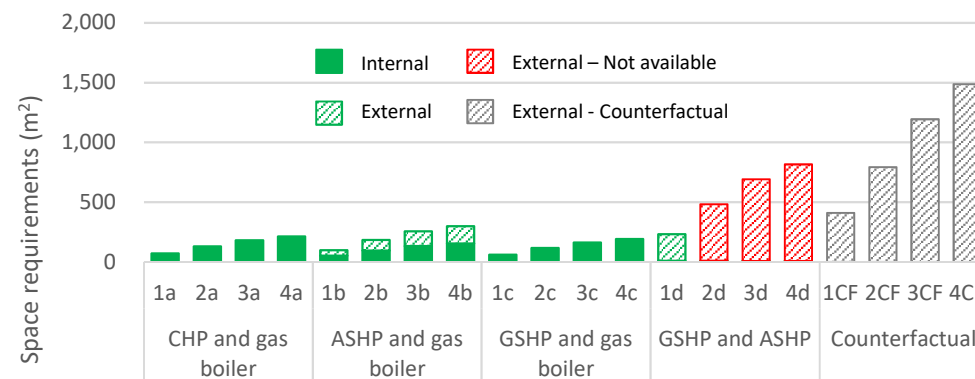


Figure 6.1 Space take requirement of each scenario

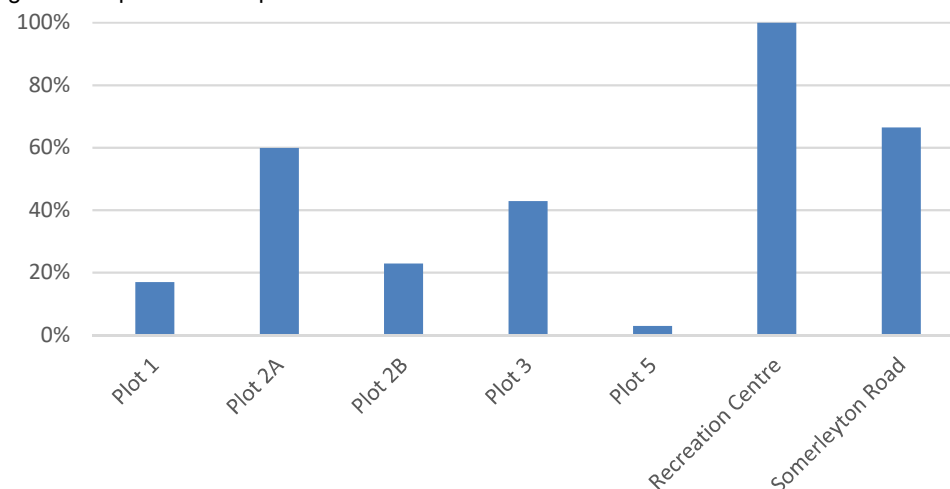


Figure 6.2 The percentage of roof space required by the ASHP counterfactual for each building

6 Energy Centre Location

6.2 Proposed locations

Energy centre location

Arup has proposed potential sites for the energy centre. The key considerations for selecting an energy centre are the ownership of the building, available space and access. Each of these metrics are discussed further in this section and recorded in Table 6.1.

Ownership

The council has set ambitious targets for emissions reduction of its own portfolio of buildings. It is therefore likely to be more motivated to connect to a DH network and even host the energy centre than a private developer would be. As such, the only areas considered for Energy Centre location are the Brixton Recreational centre, plots 1, 2A and 2B and Somerleyton Road.

Space

The highest performing DH network in both economic and carbon terms is the ASHP led solution. In the largest network (4B), it requires approximately 150m² internal space and 140m² external space. All of the proposed locations have sufficient space to house this solution.

Access

Access to the energy centre is important not only for construction phase but also for the maintenance of the plant. Access constraints considered are major roads or railways and

the height of the building. Hosting plant on building roofs would likely need cranes for installation and potentially future maintenance.

Exclusions and assumptions

The council shall require further in depth planning for the energy centre beyond this high level study. No site surveys have been undertaken, and broad assumptions have been made on space requirement and availability for the purposes of this assessment. Should the council wish to pursue a district solution, the energy centre and its location shall need to be a focus of further design development.

Table 6.1 Potential energy centre locations

Proposed Location	Considerations	RAG score
Brixton recreation centre	- Council owned 178m² external roof space, 200m² internal plant area - Roof is existing, so structure is likely not capable of supporting additional infrastructure, eg Air source heat pumps (ASHPs) which require outside space. Surveys required. - No known significant access constraints 6 storeys - Brixton Recreation Centre in grade II listed.	
Plot 1	- Council owned 446m² external roof space - No significant access constraints - Planned development so can be designed around proposals 13 storeys	
Plot 2A	- Council owned 416m² external roof space - No significant access constraints - Planned development 15 storeys	
Plot 3	- Privately owned 514m² external roof space - Between viaducts – very challenging to access roofs for construction/maintenance. - Planned development 13 storeys	
Somerleyt on Road	- Council owned 4,000 GEA - Is c.210m from closest part of the network - Planned development of 304 homes - At planning stage and could adapt energy centre.	

7. Conclusions and Next Steps

Conclusions

This study has investigated heat network opportunities for connection of various developments in Brixton town centre, as well as the existing Brixton Recreational Centre. Various technical solutions and building connectivity scenarios have been compared to an assumed counterfactual solution.

The counterfactual solution for use in the comparison was chosen to be an air source heat pump (ASHP) system for each individual building. This was selected based on it being the typical low carbon heating solution chosen by developers in order to secure planning permission under the London Plan and Part L of the Building Regulations.

Connection scenarios

Carbon, cost and space requirements for four connection scenarios (i.e. the extent of network inter-connectivity) were presented:

1. Plots 1, 2A & 2B only;
2. Plots 1, 2A, 2B, 3, 4 & 5;
3. Plots 1, 2A, 2B, 3, 4, 5 & Recreation Centre;
4. Plots 1, 2A, 2B, 3, 4, 5, the Recreation Centre and Somerleyton road.

Pipework routing

The study area is a particularly congested part of Brixton, with three overground railway lines separating the town centre developments from the Somerleyton Road development. Indicative routing shows

pipework joining these two areas crossing under the railway on Valentia Place then running south-west along Coldharbour Lane.

The viability of this route and the existence of other buried services that may prevent installation has not been investigated, but is a high risk aspect of whether this connection is deliverable.

Technology scenarios

Under each connection scenario, four potential technology solutions for supplying heat to the network were modelled:

- A. Gas CHP + Gas boiler;
- B. Air source heat pump + Gas boiler;
- C. Open loop aquifer based ground source heat pump + Gas boiler; and
- D. An all electric solution with ground and air source heat pumps.

Techno-economic analysis

Network solutions with gas boilers installed to provide peak demands (with low carbon technology meeting the 'base-load') were found to be cheaper than the alternative. This is due to the relative low cost of gas boilers in comparison to air source heat pumps.

Connecting buildings together provided better economic performance in general in comparison to the counterfactual.

Whilst ground source heat pump (GSHP) scenarios perform best due to higher

efficiencies, there are inherent risks with their use due to uncertainties of the ground conditions at the site. Whilst initial study shows that the technology could be feasible (see Appendix A), further analysis is required and test wells may be needed to corroborate assumptions.

The all-electric network solution performs worse than the counterfactual because the increase in overall heat pump efficiency obtained through the use of GSHP is not offset by the negative effects of pipe losses and pipework capital outlay.

If the council wants to pursue an all-electric solution, it is recommended to go with the counterfactual or to extend the study to investigate electric backup boilers.

The network solutions with gas mean that carbon emissions attributed to heating are higher than the counterfactual. This means additional low carbon measures would be needed (e.g. solar PV) in order to compete with the counterfactual on carbon. The alternative is making higher carbon offset payments in order for the building to be net zero carbon, as necessary under the draft New London Plan. The CHP and gas boiler solution emits the most carbon.

Space requirements

The counterfactual building-by-building air source heat pump approach requires the greatest amount of space. By implementing a district network, the council can achieve space savings through provision of peak heat demand with gas boilers. This frees up valuable roof space for other uses like solar PV and terraces/roof gardens.

The best performing and lowest risk district heating solution is to use air source heat pump (ASHP) and boilers, which requires a certain amount of roof space for the heat collectors of the ASHPs (but far less than the counterfactual). Whilst the Brixton Recreational Centre may have some internal area available for hosting of plant, it is not known whether this space is available, nor whether the roof would be capable of supporting the weight of the ASHPs. Flues for gas boilers would be necessary, which may have planning implications. It is recommended to use a new, purpose built space in one of the new plots.

By incorporating the Energy Centre into the design of the proposed council developments (Plots 1, 2A & 2B or Somerleyton Road), structural support for ASHPs can be planned in early, and space properly ring-fenced. Noise implications of air source heat pumps should also be considered, with roofs of higher buildings a key location.

Recommendations and next steps

Recommendations

District heating in Brixton town centre could help the development save significant overall plant space against the likely, all-electric, alternative of building-by-building air source heat pumps (the counterfactual). It could also save carbon emissions and be financially viable and so it is recommended further study is undertaken.

The GLA recommends that all major developments should connect to local existing or planned heat networks as a priority over using available local secondary heat sources, such as heat pumps. Installing a network would therefore be supported by planners and could help remove some of the risks around being granted planning permission.

Of the technology options modelled, those where gas boilers are used to meet peak heating loads, network options have poor air quality and carbon emission implications when compared to the counterfactual.

An alternative solution is to use electric backup boilers to meet peak demands – an option not modelled in this report due to concerns over the ability for it to compete financially with the counterfactual. There is affordable housing proposed in the Town Centre developments, so any solution that could potentially increase energy costs presents fuel poverty risks. Installation of

solar PV may help offset the additional power requirements for the electric backup boilers.

The connection of Somerleyton Road could offer good financial performance when compared to the counterfactual. This development, which has planning granted with a CHP fired network, should reassess its heat generation plant to look into alternative, lower carbon solutions. In particular, looking at availability of space for air source heat pumps (ASHPs) would help indicate whether this site could host the energy generation plant for the network. Due to the fact that Somerleyton Road is planning to build its energy centre in Phase 2 (starting 2021), hosting the energy centre for all development sites may be an enabler for the area-wide district scheme. However, there are risks around the route identified between Somerleyton Road and the other development sites which need mitigation against through ground surveys.

All electric solutions would increase the sites' demand for electricity, which presents risks around the ability to secure the necessary supply of power from UKPN. Any demand over 300kVA is likely to require reinforcement. Understanding the grid capacity limitations in the area is crucial if the council wants to pursue an all-electric solution (especially one with all-electric backup boilers).

The ASHP/gas boiler hybrid network offers the best combination of low risk and good financial performance. If this solution is pursued, some roof space on plots 1, 2A or 2B or in Somerleyton Road would need to be secured. Boiler plant and other ancillaries could be located in the existing Brixton Recreational Centre. Further design work is necessary to refine the required plant spaces and to give greater certainty on capital costs.

Next steps

District heating could offer a cost and carbon competitive solution for heating in Brixton, but needs further investigation. We propose further reallocation of decentralised energy enabling project (DEEP) funds from the Nine Elms area to Brixton, to investigate the following:

- Whether electric backup boilers could be a viable alternative to gas boilers. This requires:
 - Modelling financial performance with electric backup boilers; and
 - Engaging with UKPN to understand the implications of increased grid connection capacity requirements;
- Development phasing plans through techno-economic modelling, to assess effects of time on financial performance;
- Further refinement the space requirements of the proposed scheme; and
- The appetite of the Somerleyton Road development team (Homes for Lambeth) to understand implications of using different heat generation technology for the site than the proposed CHP, as well as the ability to host plant on that site.
- Technical viability of the proposed connection route between Somerleyton Road and the Town Centre developments;

Appendix A: GSHP feasibility

Brixton GSHP High Level Feasibility

Eren Gunuc, Alex Chen
20-09-2019

Summary

- Aquifer properties are favourable of open loop GSHP, due to moderate to high transmissivity,
- Water level is with London Clay ,
- Chalk rockhead is 70 to 80 mBGL,
- Water well is about 120m deep, cost £100 ~ 150K per well
- Assuming $\Delta T = 5 \text{ degC}$, well yield 10 l/s, each well produces 200 kW,
- There are no known open loops at least 500m radius (the known one is at 2.5km northwest)
- Need a big space to accommodate wells, allow for 150m or more separation between injection and abstraction points

Proposed GSHP Site

A3

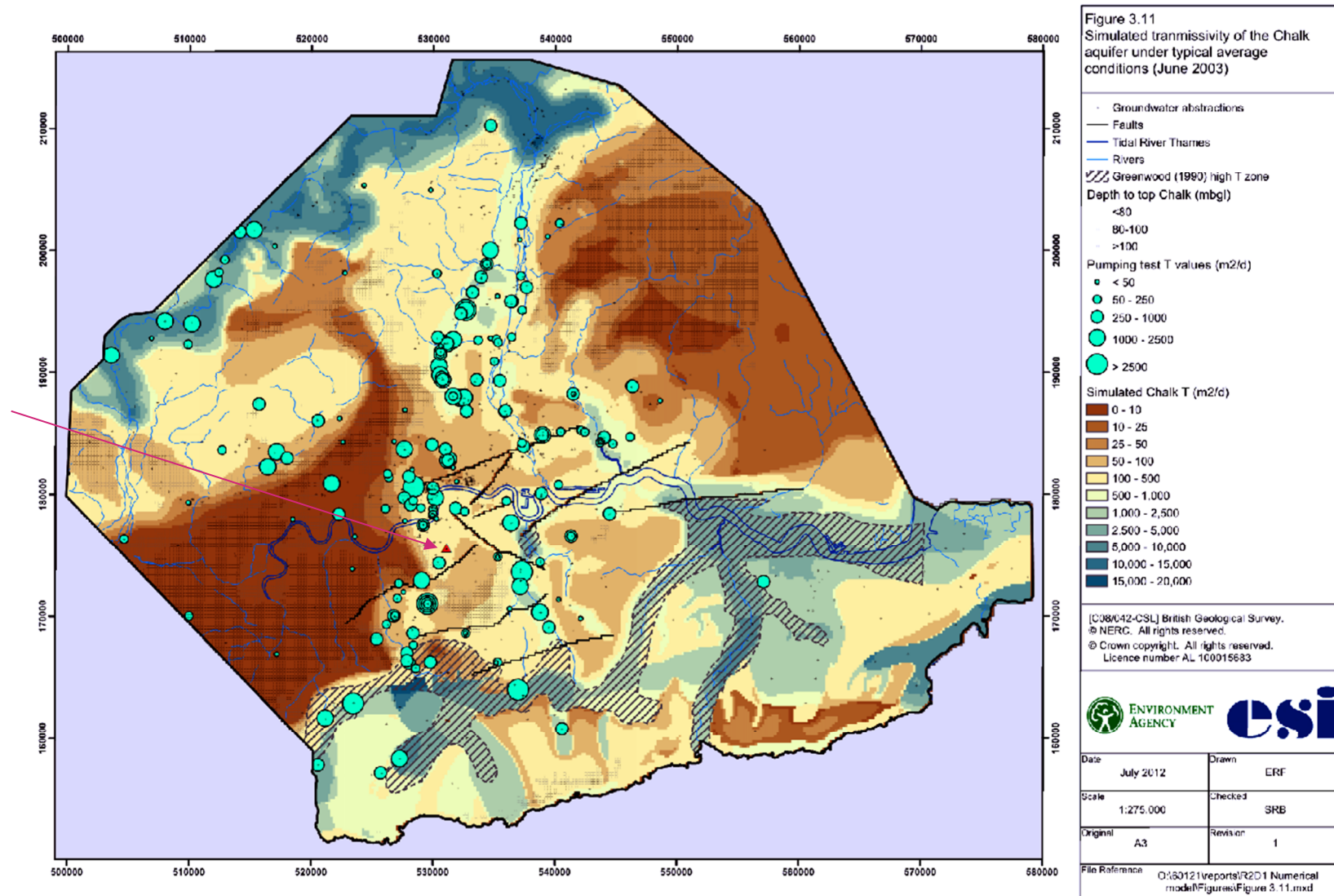


ARUP

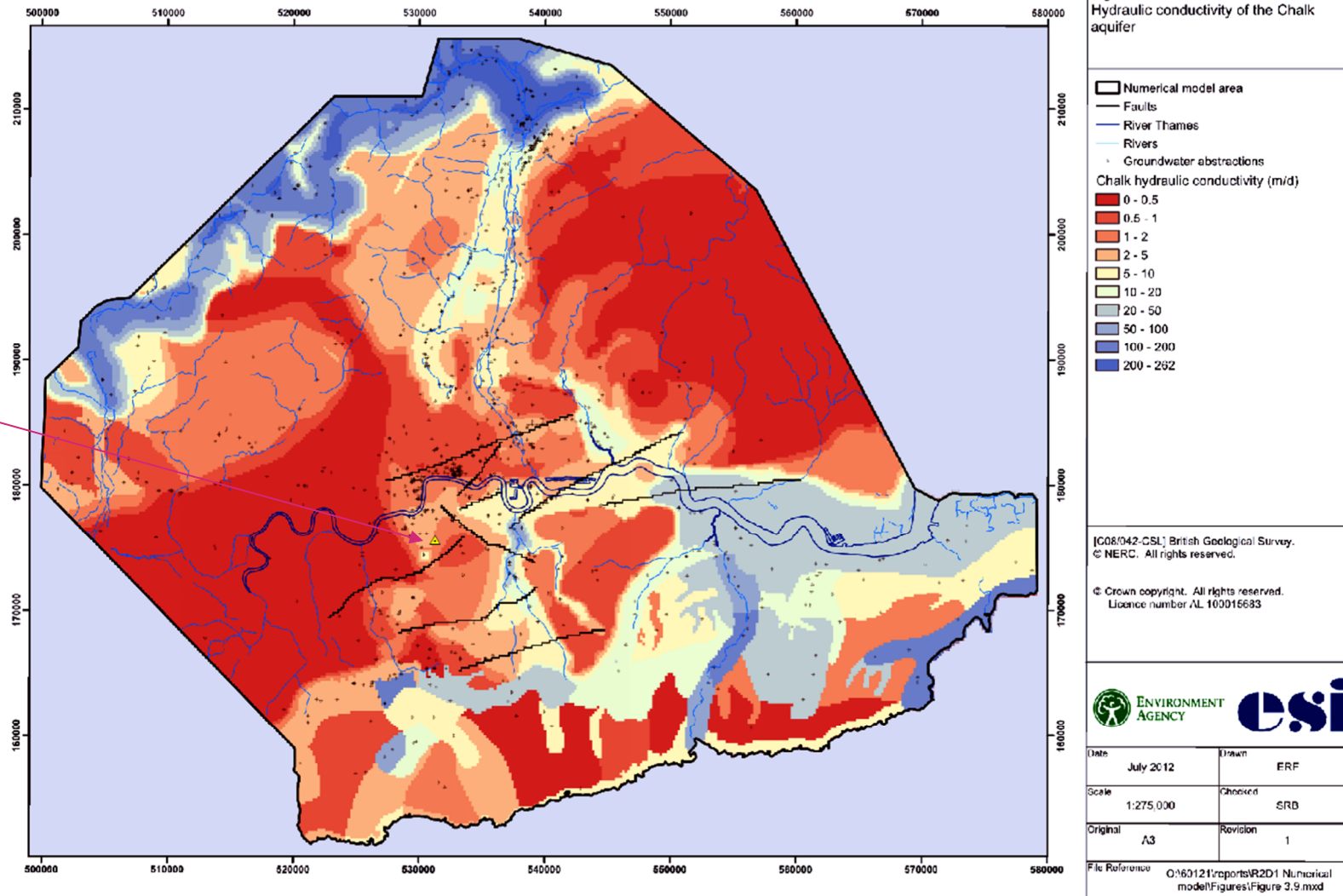
Aquifer Properties

- Transmissivity 100 to 500 m²/d,
- Top of the Chalk 75 mBGL (BH TQ37NW/1258 at 500m distance), about -53 mOD,
- Ground Level ~ +10 to +12 mOD,
- Groundwater Level: The EA GW map indicates water level is -10 ~ -20mOD, while the Lambeth Council flooding report indicates 40 to 50 mBGL (at TQ37/252A, 1.5km southwest to the site),
- No info is found in the London abstraction strategy report

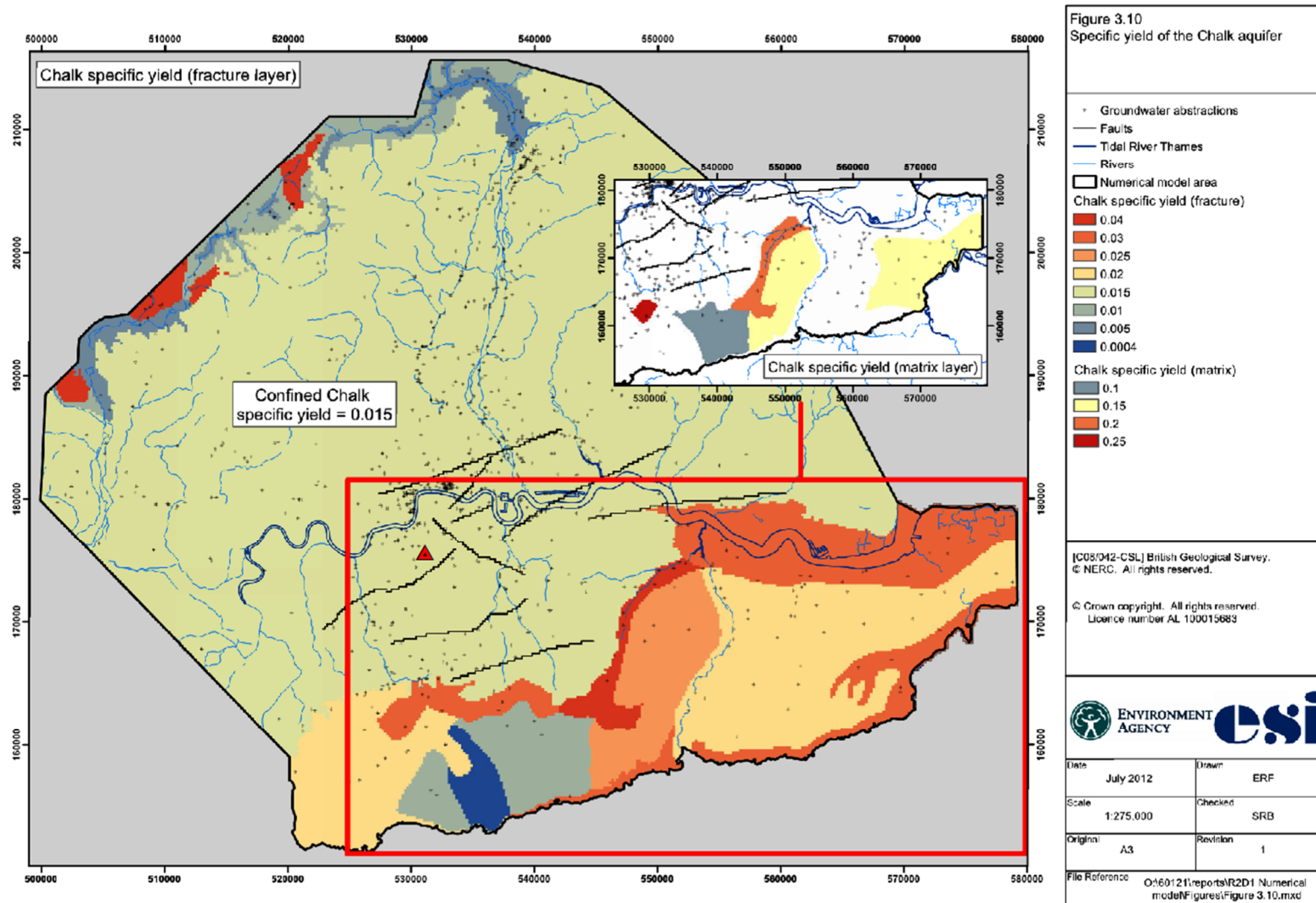
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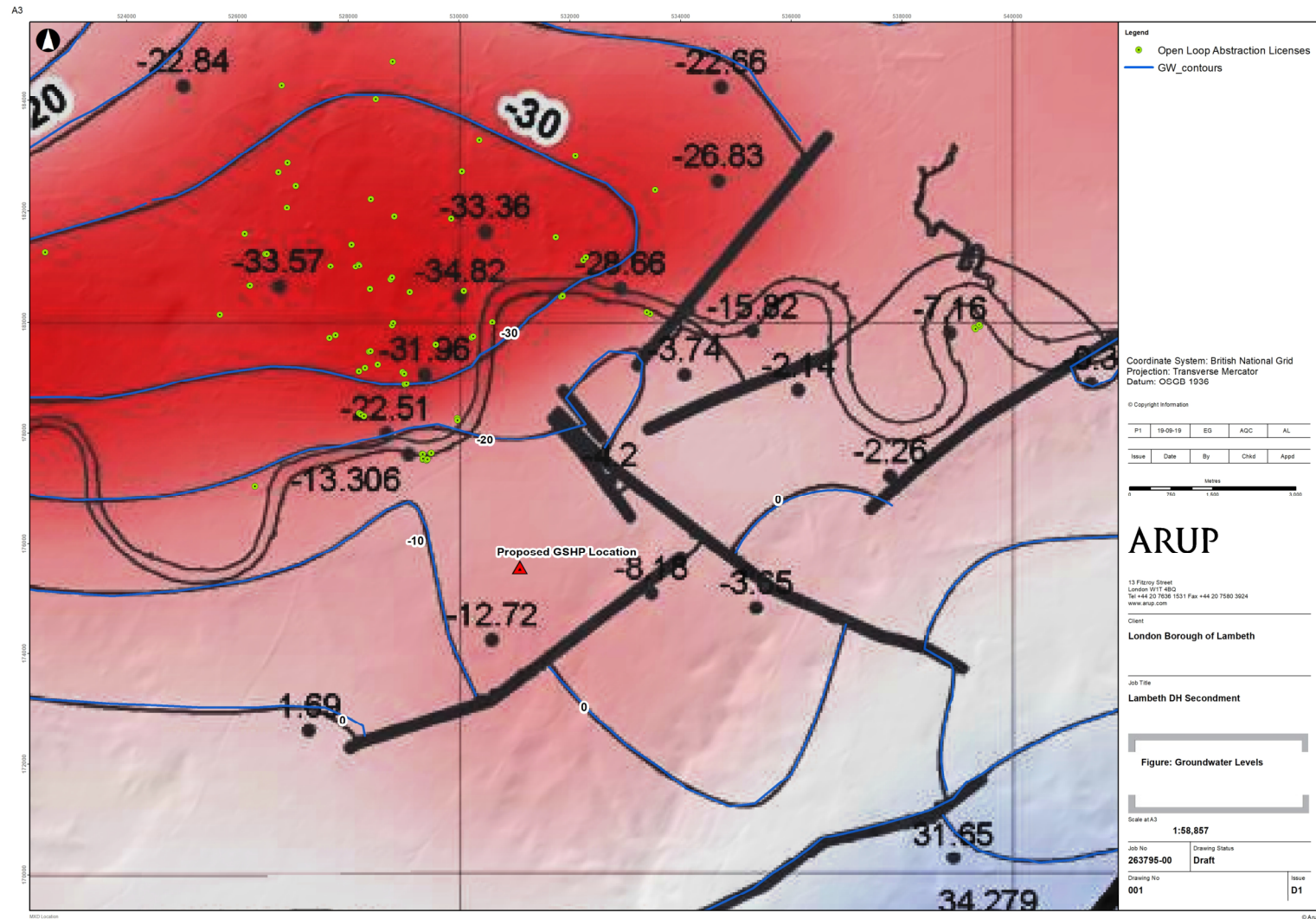
Chalk Hydraulic Conductivity



Chalk Specific Yield

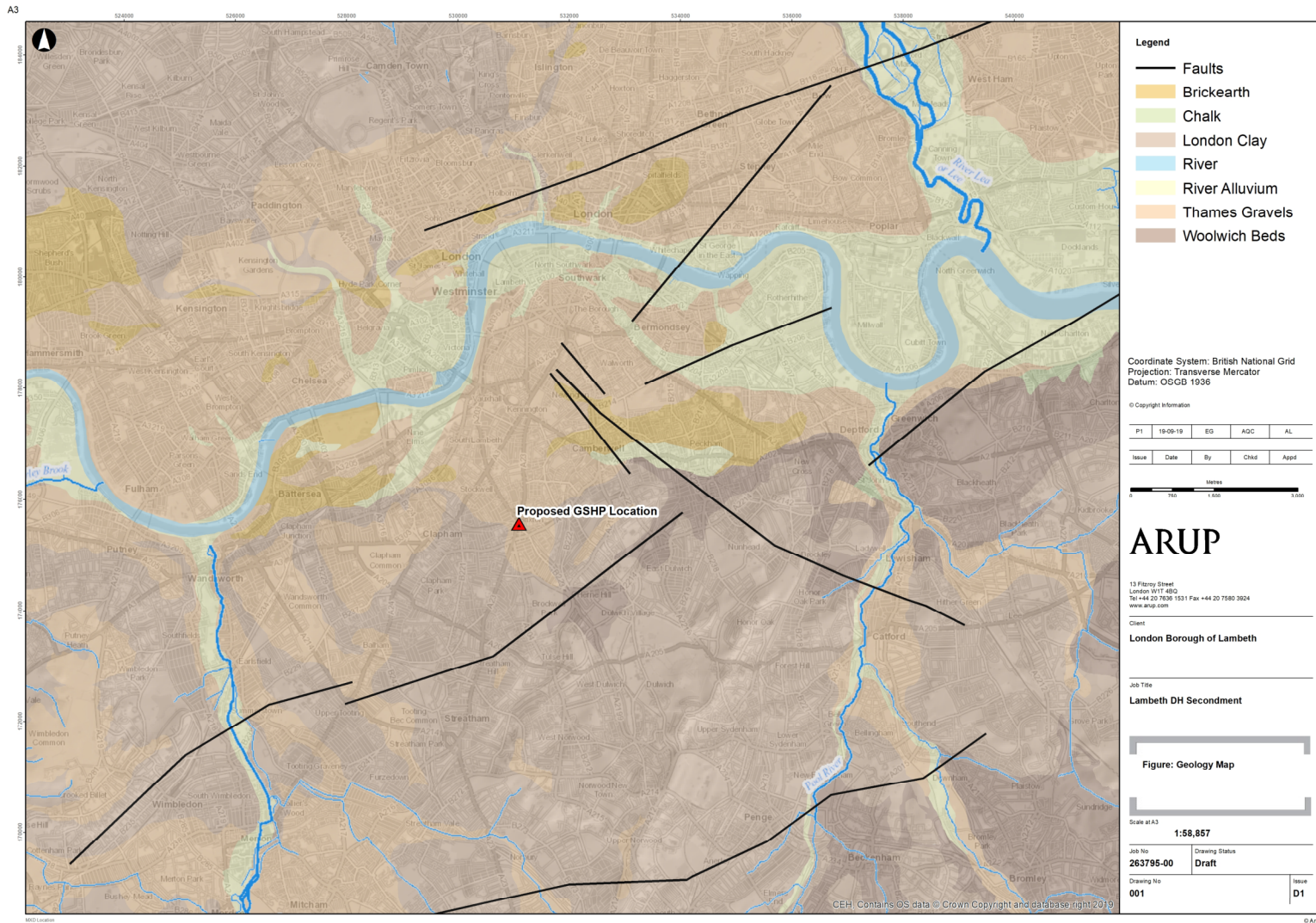


Groundwater Level



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Geology



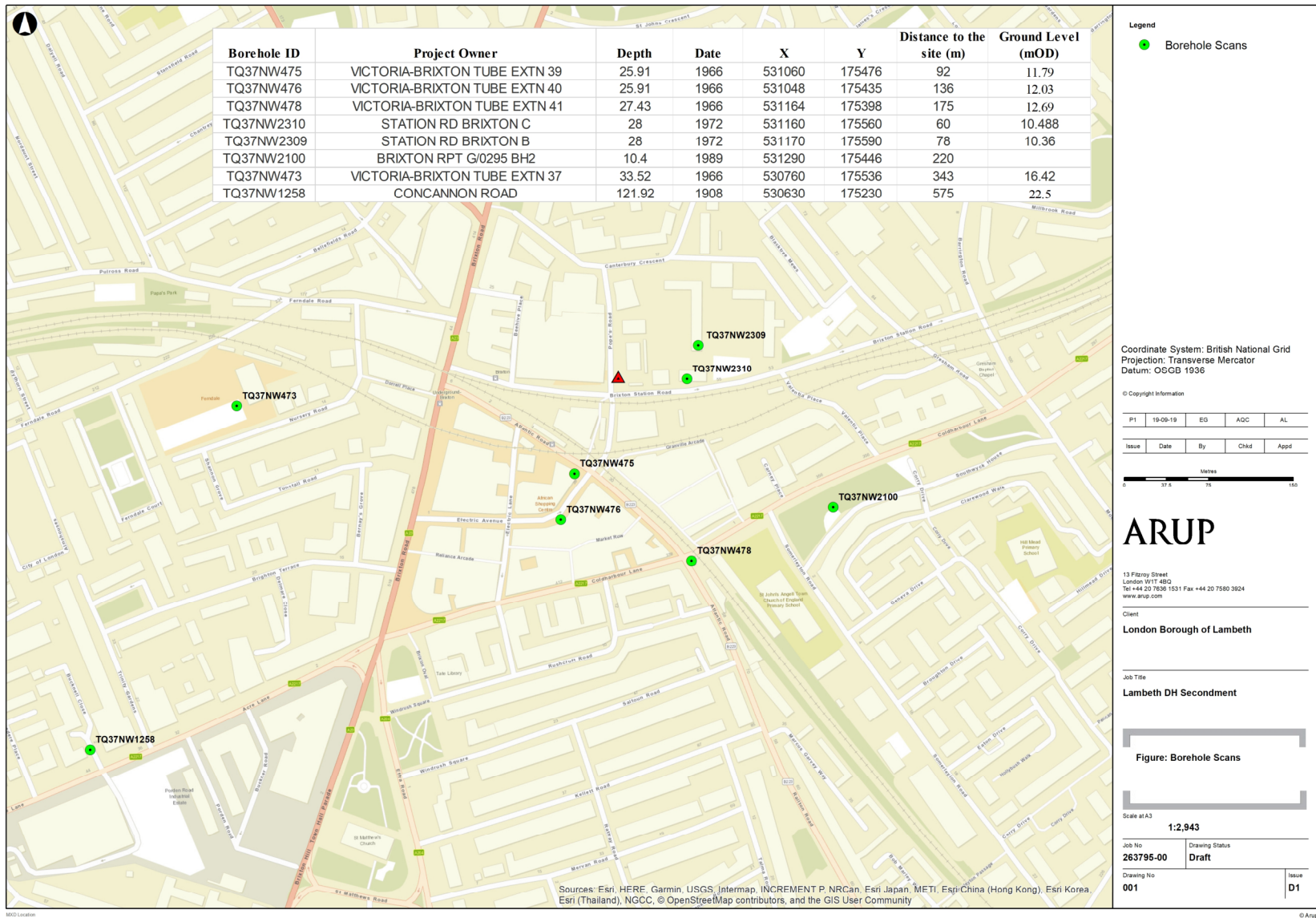
ARUP

Nearby Open Loops & SPZs



Borehole Scans

A3



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