Appendix 5 – Heat Networks Strategy Development

This appendix provides a summary of the background work undertaken in development of the Heat Networks Strategy. It includes sections on the following topics:

- Challenges to meeting the objectives
- Technology review – which technologies provide the best fit with the objectives
- SELCHP and Water Source Heat Pumps project updates, including how and why these projects can help the Council meet its objectives

CHALLENGES

1. The table below describes the challenges to operating the Council's heat networks in a manner which consistence meets the stated objectives of reliable, affordable and low carbon.

<table>
<tr><th></th><th>Effective and reliable</th><th>Affordable</th><th>Low carbon</th></tr>
<tr><td>Heating technology and other central plant</td><td>• Central plant often affected by poor water quality, which in turn is often a result of leaks in the system being replaced with untreated water.</td><td colspan="2">• There can be a tension between low carbon and affordability. Gas is no longer considered low carbon but it is still one of the cheapest options for both installation and running costs.
• Central plant items tend not to be the most expensive items to replace in a network when compared with the distribution elements.</td></tr>
<tr><td>Buried distribution pipework</td><td>• The buried pipework is the hardest to know what condition it is in, and therefore failure can occur without warning.
• Some of the Council's buried mains have leak detection systems to give early warning but most do not.</td><td rowspan="2">• Expensive to replace and can lead to expensive charges being passed on to leaseholders
• The Council may not have sufficient capital budget to allow replacement of all distribution pipework that is at end of life
• However, it can have extremely long operational life if water quality is maintained.</td><td>• Well-insulated buried pipework can have very low heat losses
• The distribution network is the key element to allowing a variety of low carbon technologies to be deployed that would not be viable in individual systems</td></tr>
<tr><td>In-building distribution pipework</td><td>• The in-building pipework is easier to inspect for condition than buried pipework but replacement can be just as disruptive or even more so due to working within residential buildings.</td><td>• Well-insulated pipework can have very low heat losses but in-building distribution can suffer from poor design and elevated losses.</td></tr>
<tr><td>In-dwelling systems</td><td>• The radiators, warm air units, pipework, valves and other elements are difficult to inspect due to being within occupied dwellings. Replacement is</td><td colspan="2">• Most tenants in the borough pay a flat rate for heat regardless of consumption. This spreads the cost of high and low consumers and helps to protect the most vulnerable.
• But it doesn't encourage energy efficient and carbon saving behaviour or allow residents to</td></tr>
</table>

	disruptive. • The main operational issues are air locks and valves becoming stuck.	make savings through life-style choices. • Moving to a system of heat meters while protecting the most vulnerable and avoiding unintended consequences will be an important operational development
Control and monitoring system	• Many of the Council's networks have remotely accessible Building Management Systems (BMS) which allow engineers to see how the main elements of the systems are working. • This early warning system helps to improve reliability and efficiency but isn't installed in all cases.	• While the existing BMS systems allow remote visibility and early warning of problems, there is more that could be done to optimise network efficiency, which would improve affordability as well as carbon emissions.

2. The key challenges to consider in relation to both existing and new heat networks in the borough are therefore as follows.

3. **Water Quality –** The Council has long been aware of the importance of water treatment to protect pipes and boilers from corrosion, but as leaks have increased in ageing networks, the cost and time involved in maintaining good water quality has also increased. If water quality is allowed to degrade, however, the rate of corrosion increases and thus leaks become even more likely and the situation becomes a downward spiral. It is important that the Council is utilising the most appropriate water quality testing and treatment regime for each network. Some situations may justify higher capital cost treatment systems that have lower ongoing costs in the long term, while others would not warrant high upfront investment. Robust testing and, critically, the analysis and monitoring of test results will allow water quality to be monitored over time. This will help the Council to identify issues early and react quickly before damage is done.

4. **Building Management System (BMS) and optimisation –** The Council is in the relatively unusual position of having a working and remotely accessible BMS installed in many of the boiler houses and plant rooms around the borough. These allow real-time remote visibility of temperatures and pressures and can raise automatic alarms when problems occur. The Council has invested significant time and money installing and maintaining the BMS systems and they have been extremely valuable as an early warning system and helped to improve reactive maintenance. However, many sites do not have remote connectivity or do not even have a local BMS controller. Where BMS systems are in place, there is additional functionality that could be used to optimise system performance. Roll-out of further BMS controls and system optimisation are an important ongoing work stream requiring further investment.

5. **Charging models (heat metering) –** Charging tenants by a flat rate "pool charge" is simple to administer and easily understood by residents, but does not encourage efficient behaviour. Charging homeowners for a share of the cost also does little to encourage efficient behaviour. Moving to a metered charging model would encourage

all users to consider how much heat they are using. As discussed in paragraphs **Error! Reference source not found.**-**Error! Reference source not found.**, the regulations covering heat metering have been amended. Prior to wider roll-out of heat meters to existing properties, it will be important to structure heat tariffs to minimise any unintended consequences. This will be covered in a future paper.

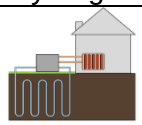
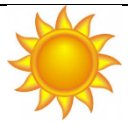
6. **Asset condition visibility**: It is often very difficult to inspect distribution pipework even when it is above ground, due to its location in service ducts or ceiling voids or due to the presence of asbestos. This makes monitoring condition and planning investments ahead of time very difficult. Even when a condition survey is carried out, full visibility is not always possible and decisions need to be made with limited information.

7. **Investment models to reduce homeowner charges –** One of the messages from the Heat Networks Residents Working Group, and other communication channels, is that leaseholders and freeholders often struggle with high capital charges related to expensive works to the heating systems. This could be from replacement mains, new boilers or complete system renewal.

8. **Adopting new heat networks successfully –** The Council is aiming to 2,500 by 2022 (completed or started on site) and many of these homes will be connected to site-wide or district-wide heat networks. New heat networks often experience different challenges to older networks and to ensure they are as reliable, affordable and low carbon as possible, the Council has recently reviewed its Employer's Requirements documents relating to new networks. This will ensure contractors know from the outset how we want them to achieve best practice in terms of design and delivery.

TECHNOLOGY REVIEW

9. This section considers how a selection of heating technologies compare in terms of their ability to meet the Council's heat network objectives to help guide the selection of technologies going forward. It is not an exhaustive analysis and there are likely to be exceptions to the rule.

Heating technology	Effective and reliable	Affordable (Capex / Opex)	Low carbon (Short / long term)
 Gas boilers	✓	✓ / ✓	✗ / ?
 Gas CHP	~	~	✗ / ?
 Energy from Waste	✓	~ / ✓	✓ / ?
 Hydrogen	?	?	**Depends on source**
 Heat pumps	✓	~ / ~	✓ / ✓
 Biomass	~	~ / ~	**Depends on source**
 Solar	~	~ / ✓	✓ / ✓

Key: ✓ = compatible; ~ = may be compatible; ? = unknown at present; ✗ = not compatible

10. The Council is committed to reducing its reliance on fossil fuel gas as it moves towards net zero carbon. Gas boilers are a mature technology with extensive supply chains for installation and maintenance, and strong national and international infrastructure supporting the fuel supply. Both capital and running costs are relatively low compared to the other technology options. However, natural gas is a fossil fuel and its combustion produces carbon dioxide emissions locally as well as, to a much lesser extent, other emissions such as oxides of Nitrogen (NOx). The sheer dominance of this heating technology within Southwark's estate means that gas boilers will continue to play a role in providing heat for many years. The carbon factor of gas is a currently a challenge but

there is some potential to synthesise methane from non-fossil sources to create renewable biogas. At present there is a relatively small quantity of biogas produced in the UK and the degree to which this can be increased (thus reducing its carbon footprint) will affect the long-term future of gas boilers.

11. Gas CHP can have exactly the same carbon arguments made about it. It used to be considered low carbon because the combined output of heat and electricity shared a lower carbon balance between them than using heat from a gas boiler and electricity from a power station. As the carbon intensity of the national electricity grid has come down this argument has weakened. Add to this the higher capital and maintenance costs associated with small scale CHP systems and some historical reliability issues, and this technology is not seen as likely to play a major part in Southwark's heat networks in the short to medium term. Exceptions to this may well exist where site specific factors support it, for example using it in hybrid configuration with heat pumps as an economic enabler.

12. Energy from Waste (specifically SELCHP) is considered a major opportunity in the east of the borough due to the existence of the SELCHP waste incinerator. Since the Council first started receiving heat from SELCHP in 2014 reliability has been exceptionally good with 100% availability from SELCHP combined with the backup gas provision and 93% of heat coming from SELCHP itself. The long-term Heat Supply Agreement between Veolia and the Council allowed the combination of capital costs, operation and running costs to be cheaper even than the gas boiler counter-factual. The system also operates with a very low carbon factor of around 58 grams CO_2 per kWh of heat compared to around 250 grams for a gas boiler. Increasing the use of waste heat from SELCHP is a significant opportunity for Southwark's heat networks in the medium and long term.

13. Hydrogen is still a relatively unknown quantity in terms of its commercial use as a heating fuel. Very few hydrogen boilers are available on the market, and currently the only way of sourcing hydrogen is to buy it in bottles or by the tanker load. With its current absence from the commercial heating market, it is impossible to comment on its affordability. It has the potential to be low carbon if made from other sources of low carbon and renewable energy. Low carbon or not, given the lack of hydrogen boilers, maintenance supply chains and fuel logistics, combined with an unknown level of affordability means that hydrogen is unlikely to comprise a major heating technology for Southwark's heat networks in the short to medium term.

14. Heat pumps capture low grade heat from the local environment and elevate its temperature to a useful level. Heat pumps are a mature technology with their essential components featuring in fridges, freezers and air conditioning systems all over the world. Their application in the UK for heating is less common than for cooling but is nevertheless still thoroughly developed with household names such as Dimplex, Mitsubishi, Samsung and Worcester Bosch among the major manufacturers. With proper maintenance, they are just as reliable as gas boilers, and supply chains are maturing all the time. The capital cost is still substantially higher than for gas boilers, and running costs are normally higher as well due to the electricity required to run the compressor pump, so this currently holds the technology back on the affordability front. Heat pumps are lower carbon than gas boilers already and will decarbonise still further

in line with electricity supplied through the national grid (see Figure 1 below). While challenges remain on the capital cost, running cost and maintenance cost, it is expected that heat pumps of various kinds will play an increasingly important role in Southwark's heat networks in the medium term.

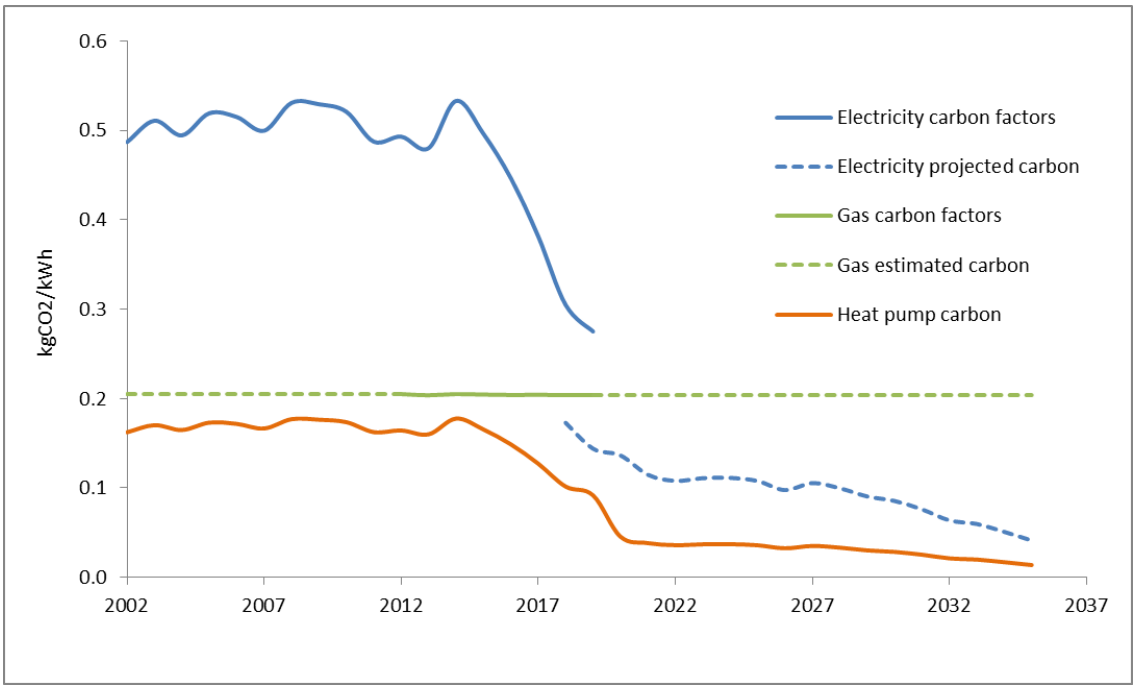


Figure 1 – Change over time of gas and heat pumps carbon factors

15. Heat pumps can capture heat from a variety of sources in the local environment. Air source heat pumps capture heat from the outdoor ambient air. Ground source heat pumps can be "closed loop" meaning they capture heat from the ground itself or "open loop" meaning they draw in warm water sitting within the ground and capture heat from that (these are technically water source heat pumps and are the type being installed at Consort, Newington and Wyndham estates). Other water source heat pumps are used to draw heat from rivers or lakes. Exhaust air heat pumps capture heat from warm stale air being expelled by ventilation systems. Sewer source heat pumps capture heat from warm waste water flowing through our sewer networks.

16. Air source heat pumps are the most common system because they are cheaper to install and don't require a local water source, large areas of ground or specific ground conditions. While still and excellent low carbon technology, air source heat pumps are not quite as efficient as other types, because the air from which they draw their heat is coldest in the winter when building heat demand is at its highest.

17. The Council commissioned some detailed research and modelling to explore the potential for implementing open and closed loop ground source systems and sewer source systems. This work looked at Thames Water's main sewer network in the borough and geological features that influence ground source heat potential. Overall the borough has very good geology from a ground source heating perspective and a few opportunities where sewer source heating might be worth pursuing. The new map layers resulting from this work (e.g. Figure 2) will help to inform decisions regarding the best

source of low carbon heat to pursue in different parts of the borough.

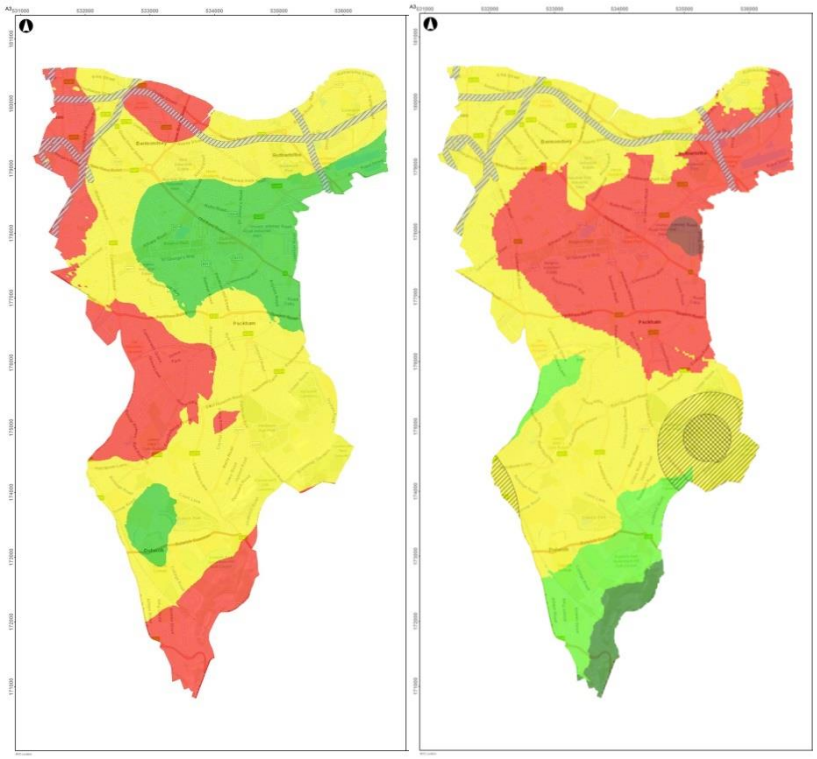


Figure 2 – Closed loop GSHP potential (left); Open loop GSHP potential (right). Red represents the highest potential

18. Biomass heating can be effective and reliable if the correct operation and maintenance regimes are employed. Biomass fuels are generally more expensive than gas, so affordability can be a problem compared with business as usual. Fuel supply chains are not as well established in city centre locations where space for fuel delivery and storage can be a significant constraint. A further challenge with biomass systems in urban areas is the air quality impact from PM_{10} and NOx emissions. The whole of Southwark is a designated Smoke Control Area and vast majority falls within an Air Quality Management Area, so while biomass is a renewable energy that can be low carbon, it is unlikely to be a suitable choice for Southwark's heat networks in the short to medium term.

19. Solar energy can be used to produce electricity or simply to capture heat. Some countries have managed to successfully integrate solar thermal collectors into their heat network infrastructure, but to do this in a meaningful way requires quite a lot of space. While the use of solar energy in Southwark's heat networks may be possible in the longer term, it likely to be only as a secondary heating source, to reduce the consumption of other fuels.

20. In conclusion then the key technologies for heat networks in Southwark in the short to medium term are likely to be gas boilers, Energy from Waste (expanding the Council's use of heat that is currently rejected at SELCHP), and heat pumps utilising a variety of heat sources (while being mindful of their capital and running costs and the impact of this upon affordability). Gas boilers will continue to be part of the mix for many years

because the Council has so many currently. New gas boilers will not be the first choice when replacements are needed due to carbon emissions and in most cases should only be installed in a supporting capacity unless other options have been shown to be unviable or where exceptional circumstances exist.

21. The two key low carbon technologies, both lend themselves particularly to district and communal heating scenarios rather than individual heating systems. With Energy from Waste, this is due to the cost of the distribution pipework that is buried underground to carry heat from SELCHP to the properties. Connecting to a single point with a large heat load (e.g. an existing boiler room) is far easier to deliver and more cost effective than making individual connections. The same is true of many types of heat pump. While small Air Source Heat Pumps can be installed to serve individual properties, ground, water and sewer source heat pumps all require significant infrastructure with high capital cost and this is best delivered on a communal or district scale.

SELCHP NETWORK EXPANSION

22. As noted above, July 2019 Cabinet approved the further investigation of the opportunity to expand the existing SELCHP heat network to increase the quantity of heat captured and supplied to Council housing estates and to new developments in the vicinity.

23. Since then the feasibility study has been completed which concluded that utilising heat from SELCHP would provide maximal environmental and economic benefits for new developments in the Old Kent Road regeneration area, as well as present a positive economic case overall for new and existing housing developments compared to the Business as Usual counterfactual options.

24. To assist developers and their consultants in undertaking energy and sustainability strategies, the Council and Veolia organised a workshop, and have subsequently worked with the Building Research Establishment (BRE) to assist in production of a Technical Briefing note. This provides carbon factors and modelling methodologies which can be used when undertaking the energy and carbon modelling calculations required by planning and building control.

25. Expanding the SELCHP heat network is easily the largest opportunity in the borough for providing low carbon heat to new and existing heat loads. Various network routing options have been modelled based upon the major existing and planned heat loads, while taking into account constraints such as major roads, railways and areas of congested underground services (e.g. gas and water pipes, electricity and telecoms cables etc.).

26. Figure 3 shows the current expected network route, though this is subject to change. The estates currently being considered for connection (shown in red in Figure 3) are Brimmington, Acorn, Cossall, Leontine, Neville, Hoyland, Pelican (Heron & Crane), Sceaux Gardens, North Peckham. This list equates to 2,928 properties. In addition there is also potential for the Tustin estate and Ledbury estate to connect as and when final decisions on these projects area reached as these are on or near to the planned heat network route. The projected carbon saving from switching the Council's housing

networks to SELCHP heat is 9,800 tonnes CO_2 per year.

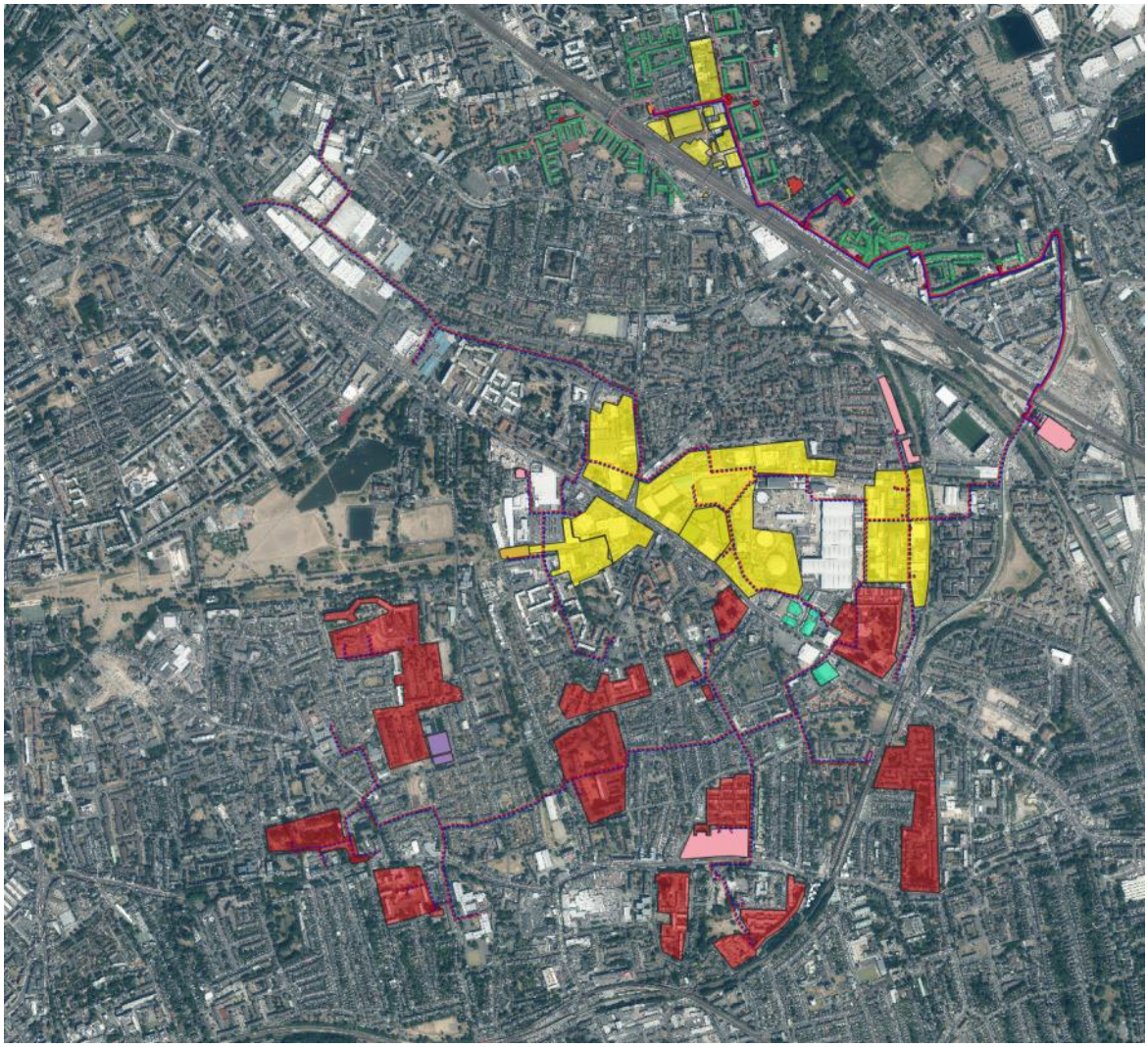


Figure 3 – Current expectation of expanded SELCHP heated network
(Key: Green is already connected loads; Yellow is proposed new developments to connect and red is proposed existing housing estates to connect)

27. Given that Veolia is the operator of the waste facility, and that the Council has an existing heat network contract with them for the first phase of the SELCHP network, the common sense approach to delivering the expansion is to vary the existing contract rather than starting from scratch. It is inconceivable that another party would be able to offer comparable terms to Veolia because no-one else has access to such a large source of low carbon waste heat.

28. The Council instructed a legal firm to check if the network expansion could be undertaken by Veolia through a variation to the existing contract, rather than going through an unnecessary procurement exercise. The expert advice received was that a contract variation would be legally permissible.

29. The Council has therefore been working exclusively with Veolia to develop the detailed design and commercial proposals. These will be checked by the Council and its independent consultants to ensure value for money is being achieved.

30. Commercially, the intention is to replicate the current Heat Supply Agreement whereby Veolia brings the capital cost for the network and the Council pays Veolia a standing charge which covers repayment of capital as well as operation and maintenance.

31. Next steps: With support from the Council, Veolia has now applied to the Heat Networks Investment Programme (HNIP) for commercialisation and capital grant funding and is waiting to hear if a grant will be awarded. If successful, it is anticipated that commercialisation activities will progress through to March 2022 when the capital grant would need to be drawn down to commence construction. If not successful, further grant applications are likely to be made, particularly in consideration of the upcoming Green Heat Network Fund.

32. Homeowner consultation is ongoing. Due to the nature of the contract, it will not be possible to follow the standard Section 20 consultation process and so the Council intends to apply for First Tier Tribunal dispensation from needing to follow the standard process. This is the process followed by the Council when it set up the initial Heat Supply Agreement with Veolia.

33. In terms of approval of the contract variation this would be dealt with through a Gateway 3 report. Section 6.6.3 of the Contract Standing Orders says "if the value of the proposed Variation is a Strategic Procurement, the decision must be taken by the cabinet or cabinet committee, after consideration by the CCRB of the report". Strategic Procurement includes non-works contracts with values of £4 million or more. It is therefore the intention to bring a Gateway 3 paper to cabinet for the approval of a variation to the SELCHP Heat Supply Agreement with Veolia.

HEAT PUMP INSTALLATIONS

34. The July 2019 Cabinet approved the further investigation of the opportunity to install water source heat pumps at certain of the Council's housing estates, using the London aquifer as the water source. Following this approval the Council undertook a detailed feasibility study for five estates: Brandon, Consort, Newington, Sydenham Hill and Wyndham.

35. Brandon and Sydenham Hill were found not to be viable at this time due to a combination of technical and economic factors ranging from aquifer potential and plant room space to enabling work costs.

36. Consort, Newington and Wyndham were all found to be both technically and economically viable. The project involves installing a 1,000 kW heat pump at Consort, 2 x 600 kW heat pumps at Newington and 2 x 600 kW heat pumps at Wyndham. Carbon savings are projected to be 3,848 tonnes CO_2 per year.

37. The procurement for the project, in the form of a mini-competition through the Council's major works framework took place in February 2020 and after a delay due to the start of the Covid-19 pandemic the design and build contract was awarded in June 2020. The

design phase took place from June to August and work commenced on site in September 2020. Works have progressed well with all bore holes drilled, tested and finalised and all heat pumps installed. Commissioning should be completed by November 2021 at Consort and Wyndham and in early 2022 at Newington.

38. The project is not funded through the capital works budget but through separate approval with funding from a Mayor's Energy Efficiency Fund (MEEF) loan, which would be repaid over the lifetime of the heat pumps with income from the Renewable Heat Incentive (RHI). This approach is possible because of the associated carbon savings. The RHI grant income associated with the project has meant that the Council has not had to charge homeowners for the works and the cost of heat on the estates will stay the same.

39. Due to Covid-19, the RHI scheme was extended but is still due to close in March 2022. There is limited information available regarding the government's proposed successor schemes - the Green Heat Network Fund and the Clean Heat Grant. Until more information is available, it may be hard to justify further heat pump projects. Without the RHI, the projects described here could have caused heating charges to increase which contradicts the 'affordability' criteria even though they would simultaneously save carbon, improve air quality and increase heating resilience. The Council should monitor government support programmes to ensure it is well placed to benefit from future schemes, and where appropriate use its influence to guide and shape the direction of such schemes.