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Notting Hill Housing

Windmill Park

Decentralised Heating Investigation Report

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Windmill Park

Decentralised Heating Investigation Report

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1. Introduction

Windmill Park is a residential development consisting 212 flats contained within 10 separate blocks. The development is served by a decentralised heating system providing heating and hot water to each flat.

The primary source of heat for the decentralised system is provided by a combined heat and power engine that, if controlled in an appropriate manner, would produce a carbon efficient heat energy supply to the development.

The flats contain twin plate heat interface units (HIU) that provide heating and instantaneous hot water from the primary heat supplied by the energy centre.

The scope of this report is to address the following questions and to provide outline recommendations for rectification of issues if found to be present.

Our instructions in respect of this report are to:

- Carry out an assessment of the whole heating system and comment on its appropriateness and efficiency.
- Provide comment on the pipework and leaks
- Detail what maintenance of the whole system is required and frequency
- Comment on the water in the pipes that has leaked and whether there are chemicals in it, if there should be and if this poses any health risk to customers
- Propose any action / works that need to happen to ensure the system runs as it should.

Undertake a review of all other M&E equipment across the site and the associated maintenance requirements.

2. Executive summary

This report is technical in nature and therefore we have provided an executive summary to give a high level appraise of the issues found at the development. Guidance is also provided below with greater detail being available in subsequent chapters of the report.

Energy Centre

The Energy Centre (Boiler House) design is of an acceptable level, however it is apparent that the consumption of electrical energy if excessively high as a result of the design and selection of various components. It may well be viable to replace / renew various components based on the long term Op-Ex savings from reduced electrical consumption and it is recommended that this option be appraised by the client.

Heating Distribution System

The heating distribution system which currently provides low temperature hot water (LTHW) at 80ºC to the Heat Interface Units installed within in all properties. The vertical and horizontal pipe runs are formed of a plastic pipework system, “Aquatherm Blue Pipe”, which has a broad range of applications including heating water. It is evident that there are discrepancies between the installation requirements dictated by the pipework supplier and the installation methodologies employed by the contractor. As a result, there is strain placed upon the joints forming part of the isolation valves to the properties with leaks evident as the water temperature in the pipework fluctuates. This condition may well start to affect other areas of the distribution such as connections to riser pipework. It is recommended that this is addressed by the contractor and it may well be prudent to replace the lateral pipework servicing the dwellings to provide a long term solution.

Heating System Water Quality

The quality of the water contained in the heating system is suspect and requires urgent independent laboratory analysis to determine whether the integrity of the metallic components of the system (Boilers, Pumps, and HIU’s) are being compromised. Samples should be taken from multiple locations on the distribution system. The test results should inform and guide a suitable water treatment control strategy to address the LTHW water quality issues.

The water quality in the radiator circuits serving the dwellings is currently unknown. This may well be out of the clients demise, however issues affecting the radiator circuits will also affect the operational efficiency and lifespan of the HIU’s. Silver would therefore highlight consideration of this fact by the client.

Boosted Cold Water System

The pressure of the boosted cold water should be addressed as it appears to be excessive given the height of the buildings situated on the development.

The size of the boosted cold water storage tank is excessive and due to its location within the energy centre may well present a risk of Legionella. A management strategy to address this should be considered.

The effects of the magnetic treatment equipment installed to the boosted cold water system are being degraded due to incorrect positioning of the equipment. Given sufficient space, the magnetic water conditioner should be installed upstream of the boosted cold water tank to maximise its effect.

3. Heating System

3.1 Installation

Heating to the entire development is generated from the energy centre which is located within the lower ground floor of block 4.

Low pressure hot water is generated from four gas fired boilers Ultramax R605 gas fired boilers as manufactured by MHS Ltd. Each boiler has a heat output of circa 380kW is provided with a dedicated circulation pump, an arrangement that will maximise the efficiencies of the boilers.

A single secondary heating pump is situated within the energy centre and is used to deliver heating water to the HIU's throughout the development.

A spill type pressurisation unit as manufactured by Flamco is provided and the setting on the unit at the time of survey was 3.6 bar.

The pipework within the energy centre is fully insulated and appears to be installed utilising steel pipework. From the energy centre the pipework where it runs below ground has been installed utilising Calpex pipework as manufactured by Brugg (information taken from O&M details). Once in the blocks Aquatherm blue pipe MF is utilised.

A Giese Energator CHP unit is connected to the system through buffer vessels and the points of connection to the decentralised heating system maximises the operational hours of the CHP s.

The system incorporates all necessary valves and incorporates and air/dirt separator and dosing pot.

The flue system has a flue fan incorporated within it that is constantly operating whenever any of the boilers are required to operate.

The boiler room is appropriately naturally ventilated.

3.2 Assessment

The energy centre installation is generally in keeping with the standard that would be expected of a system of this type.

Our rule of thumb assessment suggests that a heating capacity of between 850 W and 1,000 kW installed capacity would be appropriate. The 1,520 kW allows for a standby boiler to be available at peak load.

The CHP is sized to provide a degree of carbon reduction and would have been central to the approach in meeting the carbon emission reductions required for planning. The thermal storage would appear to be of an appropriate capacity although this would need to be confirmed through detailed calculation.

One principle difference with this energy centre is the provision of the gas booster unit which would not normally be required. The particular boilers that have been used have a requirement for gas to be delivered to the units at a minimum 25mbar. This is 5 mbar greater than the peak provided on the low pressure side of a standard gas meter and explains why a gas booster has been incorporated in to the system.

The flue includes an induction fan principally due to the horizontal length of the flue. It is not clear whether this was part of the original design due to the arrangement and location of the inverter that controls it. It should have been possible with better planning within the plant room to have avoided the need for this fan. As the fan is required to operate at every time the boilers are firing, there is an associated cost penalty in terms of energy usage that the fan incurs.

The arrangement of a primary pump for each boiler theoretically allows a low return water temperature to be delivered back to each boiler thereby maximising efficiency. There is sufficient maintenance space within the energy centre to facilitate the safe and proper maintenance of all plant items.

The secondary heating pump set is sized to deliver 27.2 l/s against 344 kPa. The pump is capable of delivering 3,500 kW when the system is operating at a desired performance with a 30ºC temperature difference between flow and return. The pump is also controlled by a pressure sensor located across the pump which limits the range in which the pump can operate. This design has resulted in a 15 kW pump operating inefficiently, increasing energy supply costs and carbon emissions.

It was noted that the pressurisation unit was set at 3.6 bar which is sufficient to serve a 10 storey building. It is suggested that the pressure at the set is reduced such that the pressure is more appropriate for the site.

3.3 Water Quality

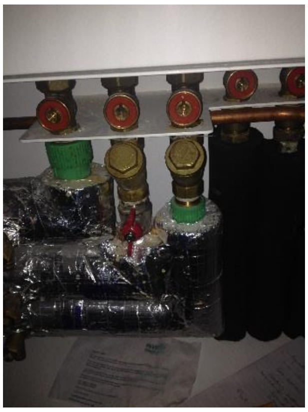
There has been a reported concern that the water within the heating system is 'black' in colour and that it possibly contains chemicals. There will undoubtedly be chemicals within the heating system and these will not be harmful to the occupants of the building during the normal operation of the heating system.

No chemical or bacterial analysis of the water has been seen or to our knowledge undertaken since completion of commissioning in March 2012. The certification states that the system has been flushed, cleaned and dosed to the requisite levels required by BSRIA and the CIBSE. A review of the laboratory figures does not raise any specific areas of concern albeit that the specific chemicals used are unknown and so the required levels of inhibitor, for example, cannot be fully assessed. There are no specific flushing and cleaning sheets contained within the operating and maintenance documentation.

As part of the water quality commissioning information we would expect documentation detailing the methods that have been used to ensure that the entire network has been appropriately treated including how all valves in each HIU were exercised in order to ensure that full circulation within the system was achieved. Without this information we are unable to confirm the validity of any flushing and cleaning process and are unable to take a view on the condition of the water at handover.

There has been a number of leaks within the system since completion and so the inhibitor chemicals and monitoring processes should be ongoing and to a level that would exceed the norm for a similar building without the leakage issues. Monthly checks on inhibitor chemical levels and quarterly chemical and bacterial analyses would be recommended.

There are signs that the potentially poor water quality is having an effect on the system and there has been a number of pump failures and signs on site that glands continue to fail.



The system contains strainers, dosing pots and air/dirt separators that all assist in keeping a clean system. On the HIU's however the strainers are located *upside down* and therefore any debris collected whilst there is flow through the strainer is returned to the system via gravity when the flow is turned off such as when the strainer is isolated for maintenance.

In system's where there is an extensive use of plastic pipework any 'corrosiveness' within the water can be concentrated at the sections that are metallic in construction, predominantly in the boiler room which houses expensive pieces of equipment and in the HIU's located in the resident's demise. *The maintenance of good water quality is therefore critical*. The boiler's heat exchanger contains aluminium and so the water quality must be contained within strict pH value limits if corrosion of the boilers is not to occur.

There does appear to be an issue with water quality and it is recommended that a full chemical and biological analysis of the water be undertaken. The samples should be taken from a number of locations throughout the system. The strainers should be cleaned and any debris found should equally be analysed.

With this information an assessment of the system condition can be undertaken.

4. Aquasystem Pipework

4.1 Installation

The heat from the energy centre is distributed by a dedicated pump set circulating the heated water through a distribution system to each block. Within the blocks a single heating riser extends to all floors from where the pipework routes at high level within the ceiling void to each flat. This heating water is then used to heat water for heating and hot water purposes within the flat through heat interface units (HIU).

Each HIU consists twin plate heat exchangers, secondary heating pump, pressure valves, control valves, controls and heat metering.

The heating water within the flats is generated by passing the primary heating water from the decentralised system across a plate heat exchanger which then heats the flat heating circulation system connecting to radiators within each of the rooms. The heat exchanger acts as a hydraulic break, meaning that the heating water internal to the flat does not mix with the decentralised system water.

Hot water is generated for the flat in a similar manner to that for the heating with a separate dedicated heat exchanger within the HIU.

The provision of hot water through the decentralised system results in a system that is required to be constantly hot as the demand for heat remains throughout the year and is required at all times during the day. The length of pipework between the energy centre and the flats means that if the water within the distribution pipework was allowed to cool then for hot water to be delivered from a tap, all the water within the decentralised system would need to be heated prior to delivery of hot water. The time delay to achieve this would be extensive.

The primary decentralised heating system distribution pipework within each block has been installed utilising Aquatherm Blue Pipe which is a polypropylene system that is marketed for chilled water, hot fluid and various industrial applications. Valves are located at the entry point to each flat and these have been installed using plastic valves manufactured from similar materials as the pipework system and sourced from the same manufacturer.

At times of system heat up and cooling down there is extensive leaking from the isolation valves located outside each flat. During the survey at every entry point inspected the insulation had been stripped back suggesting that attendance had been made to the valve set to address leakage. There were signs of water leakage at the vast majority of valve access panels ranging from damage to the ceiling to water marks at the rear of the access panels.

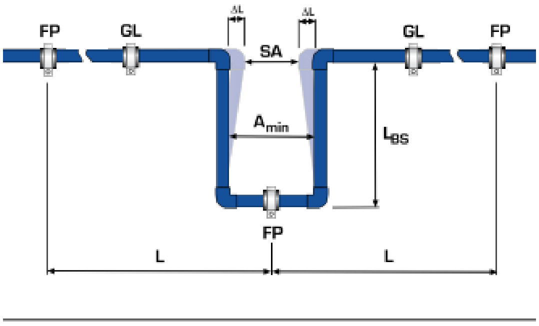
4.2 Assessment

As with any heating system there will be expansion that is caused by the heating water within the pipework and due to the cooling of this water. Expansion takes place when the system is put in to commission. The installation is installed at the prevailing ambient temperature, and expands when it is heated. Adequate provision to accommodate this expansion should be incorporated in to the heating system such that, when the heating is switched on, damage does not occur to the pipework.

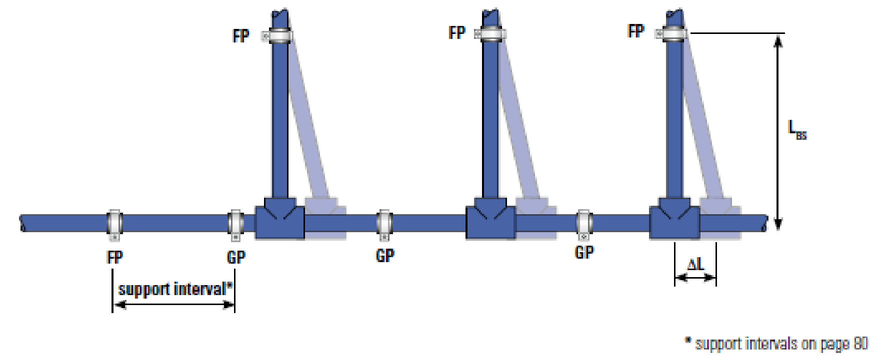
The system design must recognise all operating conditions that the system is likely to encounter. This includes the heating up and cooling down of the system in response to the demand for heating and hot water, the failure of plant and equipment and the general maintenance of the system without affecting the expected longevity of the pipework installation.

Leaks have presented throughout the system, principally located within the corridors and at points that are at the valved branched off connections to the flats. These are the locations where the greatest tension from movement caused by pipework expansion and contraction occurs.

Pipework expansion would normally be addressed through a number of methods. Expansion loops in pipework as detailed on the diagram below is a typical method. Pipe offsets is another method that is similar to the diagram with half the expansion of that provided by the loop accommodated



Using the same principle as direction changes, branches need to compensate for linear expansion in pipes. The manufacturer's detail below considers a continuous run of pipework branches.

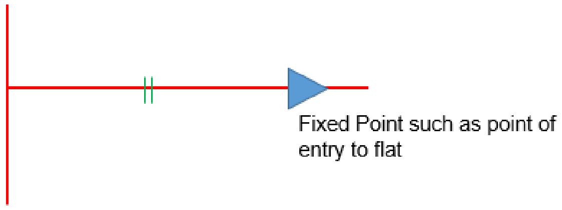


Where there is insufficient allowance for expansion, excessive stresses can occur within the pipework system and these result in joints and junctions being pulled leading to damage.

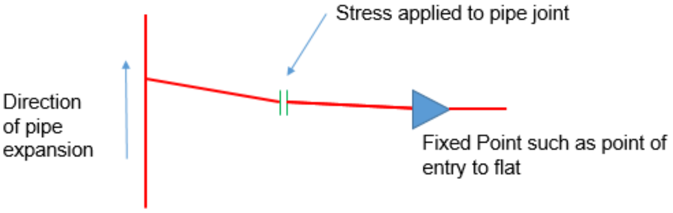
In district heating systems the pipework is generally maintained at a constant and relatively high temperature. It would appear that the plastic pipework adopts the form and shape of the expanded system as it is not allowed to reform to its original shape for prolonged periods of time. At the time when these systems contract, stresses are incurred when the pipework attempts to recover in to its original shape and arrangement. Stress is put on the pipework system at this time. The following diagrams describe the action and forces that occur.

Having reviewed the manufacturer's installation recommendations it would appear there is a discrepancy between the manufacturer's published recommendations and the installation on site.

The difference being that there are valves installed within the branch connections. The stress created by the expansion of the pipework is directly applied to the valve joints. The following details identify the stresses and the likely additional flexing that occurs at the valve junction.



Arrangement as initially installed



Stresses on Heat Up

It is apparent that the valve connections to the pipework system are not sufficiently robust to accommodate the stresses that are being applied to them. The lack of robustness results in leaks at the valve joints that are likely to occur both at times of original heat up and whenever the system is allowed to cool down.

In order to address this issue there will need to be a redesign of the pipework system within the corridor ceiling voids and possibly even pipework replacement as any reinforcement and fixing around the valves will lead to a lack of expansion accommodation in other areas.

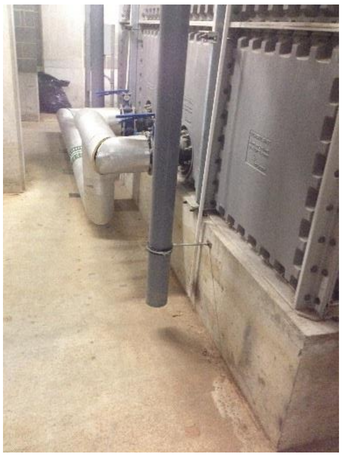
As a temporary measure and where water is penetrating flats at times of system cool down, a puddle flange type arrangement can be used adjacent to the pipework entry in to the flat. This arrangement will assist in preventing water entering the flat but will not address the leaking from the valve joints in any way.

5. Boosted Cold Water Service

5.1 Installation

The boosted cold water service consists of a partitioned sectional cold water storage break tank located within the energy centre. From the tank water is piped and boosted through a triple pump set which has speed control via inverters maintaining a constant discharge pressure.

The break tank has a capacity of circa 21,000 litres and has magnetic water treatment unit connected to the incoming mains cold water service. Any water entering the tank therefore has a dwell time within the tank degrading the effect of the magnetic water treatment prior to its delivery to the site.



The tank itself has been mounted on a flat base. The sectional arrangement of the tank means that the base has internal flanges that present issues with being able to fully drain the tank. This is not an abnormal situation however in this instance there is a risen concrete base and by providing piers instead of a complete base would have permitted the preferable situation of an externally flanged tank with the added health and maintenance benefits of being able to fully drain the tank.

5.2 Assessment

The capacity of the break tank is far in excess of what would be expected for a development of this type. This would appear to be the result of an over estimate of the domestic water requirements for the entire site.

The booster set has been sized to deliver in excess of 22 l/s and a quick review of the system and evaluation against BS EN 806-3 suggests that a value of around 10 l/s would be more appropriate.

The break tank minimum size would normally be calculated on 15 minutes operation of the booster pumps at peak flow rate resulting in an estimated size of circa 9,000 litres against the 21,000 litres installed.

There are a number of concerns with the current arrangement in that

- The oversized tank which is located within the energy centre will be subject to heat gain particularly during the summer. This would result in warm water delivered to the residents and a possible legionella issue that would require additional management.
- The dwell time of the water within the cold water storage tank increases and is likely to exceed that for the period where the magnetic water treatment unit's conditioning remains effective.

- The minimum system flow rate at which the booster set will comfortably operate is 4.17 l/s. The system will frequently operate below this value for extended periods of time resulting in poor pump control and potentially pump damage.

In addition to the rate issues it would appear that the pump set was designed and commissioned at a level of approximately 6 bar. There are no specific details in the operating and maintenance documentation which is a specific fault in the provision of this information and potentially the settings of the pumps.

A delivery pressure of 6 bar is too high for the relatively low rise development as it is more commensurate with a development of 10 storeys.

Where the metal cladding had separated at the junctions of the pipework within the energy centre it was apparent that the insulation thickness was insufficient to appropriately address the heat gain form the environment in to the pipework system.

6. Electrical Power Consumption

A specific concern was raised in respect to the ongoing cost of electrical power to the energy centre. A breakdown of costs were forwarded by Caroline Brooks on 7 April 2015 and the comments relate to the specifics contained within this schedule that is contained within appendix A.

a. The cost of electrical power between 30 August 2012 and 16 December 2013 ranged between 21 p/kWh and 25 p/kWh. From 17 December 2013 the rate was reduced to 10.1 p/kWh.

b. There has been a significant reduction in load as of September 2013. Records of any resetting, recommissioning or other works need to be made available so that it can be understood what has created this energy benefit.

c. There is an underlying and constantly high load on the system. The system contains inefficiencies such as the flue fan and gas booster. Couple to this the oversizing of the boosted cold water pump set and the heating secondary pump set and the high underlying load is explained.

7. Conclusions

The arrangement of the services, within the energy centre, on initial inspection does not raise any particular concerns although on closer inspection there is an issue with over sizing and system set up that is significantly increasing the operational cost of the system.

Specifically the set up and operation of the following needs to be reviewed and addressed

- Cold water booster set
- Primary decentralised heating pump set

The energy penalties appear so significant that replacement of these plant items may be a viable option. The water quality of the system raises a number of concerns and there are signs that the plant is deteriorating far quicker than it should in a well installed and maintained system. A full analysis of the water quality should be undertaken urgently and a programme of remedial actions put in place. The strainers serving the HIU's should be relocated so that they are maintainable.

There is an issue with the Aquasystem distribution pipework and the manner with which it has been installed. The valves are weak points in the system and are leaking at times of heat up and cool down. A full evaluation as to how this issue can be remedied in the most cost effective manner needs to be undertaken. Supports around the valves will lead to the transfer of stresses to the pipework system and could lead to other issues on the system.

Further issues such as the insulation thickness to the cold water distribution pipework and the potential reduction in the water storage capacity should be detailed in the water risk assessment for the property.

Appendix A

Energy Cost Spreadsheet

Report No	Report Date	Client Site Ref	Client Meter Ref	Supplier	Address	Meter Serial No	Supplier Account No	Invoice No	Tax Point	Bill Period From	Bill Period To	Meter Reading Type	Supplier Total	Supplier VAT	Supplier Total inc vat	Meter Read prev1	Meter Read curr1
388	15/04/2013	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGULB3H9	11/04/2013	30/08/2012	14/11/2012	Supplier Reading	8736.95	436.85	9173.8	15	40957
388	15/04/2013	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGULB3JB	11/04/2013	15/11/2012	31/01/2013	Supplier Reading	8056.03	402.8	8458.83	40957	77748
398	25/06/2013	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGULRFC4	07/06/2013	01/02/2013	31/05/2013	Supplier Reading	11936.82	596.84	12533.66	77748	127760
410	16/09/2013	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGUMGL63	06/09/2013	01/06/2013	31/08/2013	Supplier Reading	10513.62	525.68	11039.3	127760	170724
423	16/12/2013	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGUM577S	06/12/2013	01/09/2013	30/11/2013	Supplier Estimate	5271.25	263.56	5534.81	170724	191681
427	20/01/2014	LH	8833/513	Npower	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	KH62222C	LGUND457	08/01/2014	01/12/2013	16/12/2013	Supplier Reading	987.61	49.38	1036.99	191681	195612
426	14/01/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31677298	31/12/2013	17/12/2013	31/12/2013	Supplier Estimate	462.52	23.13	485.65	195612	200163
430	10/02/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31734444	29/01/2014	01/01/2014	31/01/2014	Supplier Estimate	1122.97	56.15	1179.12	200163	211253
434	10/03/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31779715	26/02/2014	01/02/2014	28/02/2014	Supplier Estimate	1024.41	51.22	1075.63	211253	221371
438	07/04/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31838517	27/03/2014	01/03/2014	31/03/2014	Supplier Estimate	1045.61	52.28	1097.89	221371	231686
442	07/05/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31895377	25/04/2014	01/04/2014	30/04/2014	Supplier Estimate	893.68	44.68	938.36	231686	240484
447	09/06/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	31956632	27/05/2014	01/05/2014	31/05/2014	Supplier Estimate	873.72	43.69	917.41	240484	249077
451	07/07/2014	LH	8833/513	Opus Ene	Landlords Supply, Oak Lodge (Powerplan), Talbot Close, MitchamUnited Kingdom, CR4 1FE	E12BG02416	589537/977122	32017494	26/06/2014	01/06/2014	30/06/2014	Supplier Estimate	839.67	41.98	881.65	249077	257334
															50517.79 to end Feb 14		