



Title: City Road City of London (excluding 33kV)

LPN Regional Development Plan

Version: 2.2

Date: March 2014

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Document History

Version	Date	Revision Class	Originator	Section Update	Details
1.0	21/06/2013		Barry Walker		First Submission
2.0	06/03/2014	Minor	Panagiotis Xenos	Contents	Updated table of contents
2.0	06/03/2014	Minor	Panagiotis Xenos	1 Executive Summary	Revised and edited the text/content/wording
2.0	06/03/2014	Major	Panagiotis Xenos	1 Executive Summary	Updated NAMP summary table
2.0	06/03/2014	Major	Panagiotis Xenos	1 Executive Summary	Updated LI figure
2.0	06/03/2014	Major	Panagiotis Xenos	1 Executive Summary	Added HI figures
2.0	06/03/2014	Minor	Panagiotis Xenos	2 Network Configuration	Revised and edited the text/content/wording
2.0	06/03/2014	Major	Panagiotis Xenos	2.2 Embedded Generation	Updated text and embedded generation table
2.0	06/03/2014	Major	Panagiotis Xenos	2.3 Projects in Progress	Updated list and description of ongoing schemes and NAMP costs summary table
2.0	06/03/2014	Minor	Panagiotis Xenos	3 Network Development Considerations	Revised and edited the text/content/wording
2.0	06/03/2014	Major	Panagiotis Xenos	3.2 HI Profile – Without Intervention	Updated HI tables pre-intervention; added HI table for FFC's and comments
2.0	06/03/2014	Major	Panagiotis Xenos	3.3 Security of Supply Analysis	Updated P2/6 assessment and LI table pre-intervention
2.0	06/03/2014	Minor	Panagiotis Xenos	4 Recommended Strategy	Revised and edited the text/content/wording
2.0	06/03/2014	Major	Panagiotis Xenos	4.1 Asset Replacement	Updated list and description of proposed schemes
2.0	06/03/2014	Major	Panagiotis Xenos	4.2 Reinforcement	Updated list and description of proposed schemes
2.0	06/03/2014	Major	Panagiotis Xenos	4.3 Costs and Phasing	Updated NAMP summary table
2.0	06/03/2014	Major	Panagiotis Xenos	4.4 HI / LI Improvement	Updated HI / LI tables post-intervention; added HI table for FFC's and comments
2.0	06/03/2014	Major	Panagiotis Xenos	5 Rejected Strategies	Revised and edited the text/content/wording
2.0	06/03/2014	Minor	Panagiotis Xenos	6 References	Updated references table
2.0	06/03/2014	Minor	Panagiotis Xenos	6.1 Appendices	Updated appendices table
2.0	06/03/2014	Major	Panagiotis	Appendix A, B, C &	Added appendices A, B, C & D

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

[illegible]

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Contents

1	EXECUTIVE SUMMARY	6
2	NETWORK CONFIGURATION	9
2.1	EXISTING NETWORK	9
2.2	EMBEDDED GENERATION	9
2.3	PROJECTS IN PROGRESS	10
2.3.1	Limeburner Lane: Establish New 132/11kV Substation	Error! Bookmark not defined.
2.3.2	Plumtree Court – 11kV Switchboard Extension	11
2.3.3	Calshot Street: Establish 2x66MVA 132/11kV Substation	12
2.3.4	Back Hill 11kV: South Group Transfer to Fisher Street	13
2.3.5	Permanent Transfer of Beech St B SE Group to Plumtree Court New Switchboard	123
2.3.6	Finsbury Market: Deep Cable Tunnel Extension	13
2.3.7	Cost Phasing for Projects in Progress	13
3	NETWORK DEVELOPMENT CONSIDERATIONS.....	14
3.1	DEVELOPMENT AREAS	14
3.2	HI PROFILE – WITHOUT INTERVENTION.....	15
3.3	SECURITY OF SUPPLY ANALYSIS	17
3.4	OPERATIONAL AND TECHNICAL CONSTRAINTS.....	19
3.5	NATIONAL GRID	20
4	RECOMMENDED STRATEGY	21
4.1	ASSET REPLACEMENT	21
4.1.1	Finsbury Market B Install 33kV Auto Close Scheme	21
4.1.2	Finsbury Market B 33kV - Replace Grid Transformers (GT1B, GT2B, GT3B).....	21
4.1.3	City Road C 11kV - Replace Grid Transformer (GT3).....	21
4.1.4	Finsbury Market A 11kV - Replace Grid Transformer (GT2A)	21
4.1.5	Paternoster - Replace Primary Transformer (T4).....	21
4.1.6	Finsbury Market A 11kV - Refurbish Grid Transformers (GT1A, GT3A) Error! Bookmark not defined.	
4.1.7	City Road B 11kV - Refurbish Grid Transformers (GT1, GT2).....	Error! Bookmark not defined.
4.2	REINFORCEMENT.....	22
4.2.1	Ludgate Circus: Establish 11kV Site.....	22
4.2.2	11kV Load Transfers to Calshot Street MSS.....	23
4.2.3	Paternoster 33/11kV - Reconfiguration to Finsbury Market B (33kV Circuits)	23
4.2.4	Finsbury Market B 33kV Feeder Reconfiguration.....	23
4.3	COSTS AND PHASING.....	24

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

4.4	HI / LI IMPROVEMENT.....	24
5	REJECTED STRATEGIES	28
5.1	CALSHOT STREET: ESTABLISH 2X66MVA 132/11kV SUBSTATION.....	28
5.2	PLUMTREE COURT - 11kV SWITCHBOARD EXTENSION	28
5.3	LUDGATE CIRCUS: ESTABLISH 11kV SITE	28
5.4	PATERNOSTER 33/11kV - RECONFIGURATION TO FINSBURY MARKET B (33kV CIRCUITS)	28
6	REFERENCES.....	29
6.1	APPENDICES	29
6.2	DOCUMENT HISTORY	29
7	DOCUMENT SIGN OFF.....	29
	APPENDIX A: GEOGRAPHICAL LAYOUT	30
	APPENDIX B: SINGLE LINE DIAGRAMS – EXISTING NETWORK	31
	APPENDIX C: SINGLE LINE DIAGRAMS – RECOMMENDED STRATEGY	33
	APPENDIX D: SCHEMATIC DIAGRAM – EXISTING TUNNEL NETWORK	35

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

1 Executive Summary

This document reviews the LPN EHV network supplied from City Road 400/132kV Grid Supply Point (GSP) which has an aggregated peak group demand of circa 799MVA (Winter) and 876MVA (Summer). It presents the schemes which are currently under construction and impact the HV network and provides recommendations for future interventions for the ED1 period.

The strategy for the development of the network during DPCR5 has included the introduction of a new 33kV distribution network in the city to facilitate the connection of new large developments with a power demand typically greater than 5MVA. The 33kV network development is now covered by a separate RDP.

The study area covers substations supplied by the City Road GSP National Grid exit point.

Proposed Interventions

The proposed interventions above £1M are as follows:

- Finsbury Market B 33kV - Replace Grid Transformers (GT1B, GT2B, GT3B) £4.2M
- City Road C 11kV - Replace Grid Transformer (GT3) £1.6M
- Finsbury Market A 11kV - Replace Grid Transformer (GT2A) £1.6M
- Ludgate Circus: Establish 11kV Site £1.8M (£1.7M in ED1)
- 11kV Load Transfers to Calshot St MSS £1.5M
- Finsbury Market B 33kV Feeder Reconfiguration £1.1M

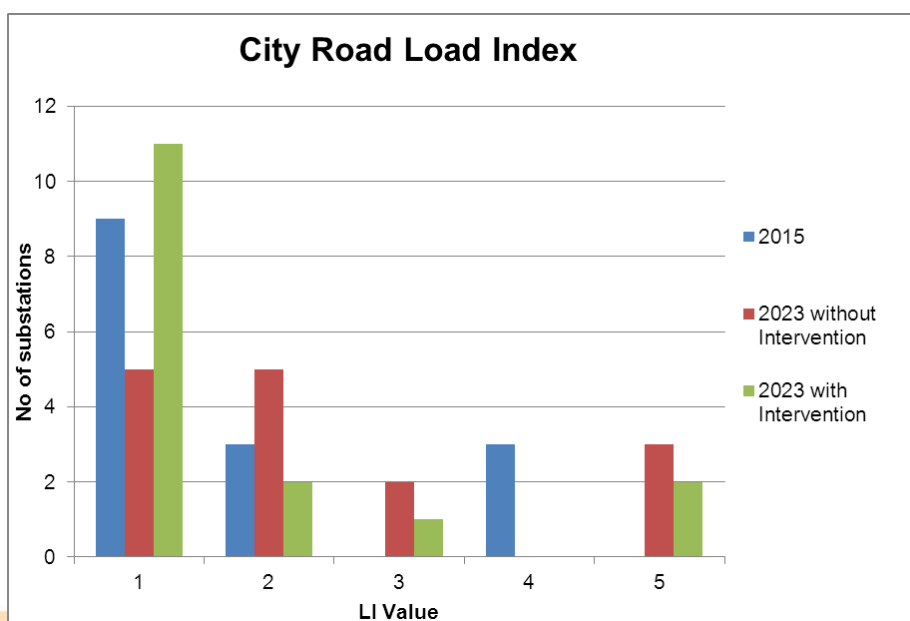
Costs profile

Table 1: NAMP Summary – 19th February 2014

Cat.	Description	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A & H	Total Asset Replacement	0	9,057	525,570	3,671,052	76,656	2,771,861	1,385,927	0	163,009	214,028
R	Total Reinforcement	0	0	0	184,692	1,784,373	885,893	41,199	0	185,100	1,506,108
	Grand Total	0	9,057	525,570	3,855,745	1,861,029	3,657,753	1,427,126	0	348,109	1,720,136

Output Measures – Load Index

The forecast load indices for 2015 and 2023, with and without intervention, are shown in the figure below:

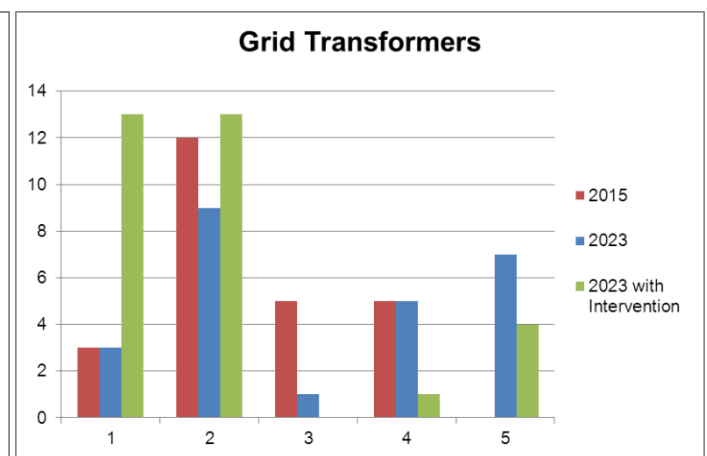
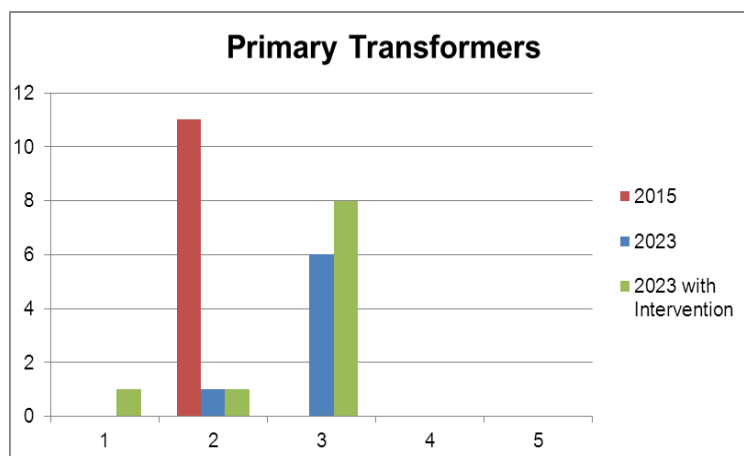
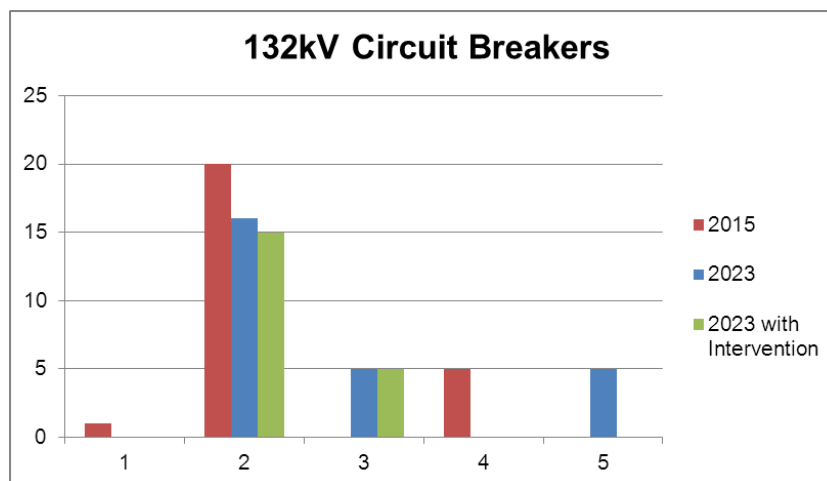
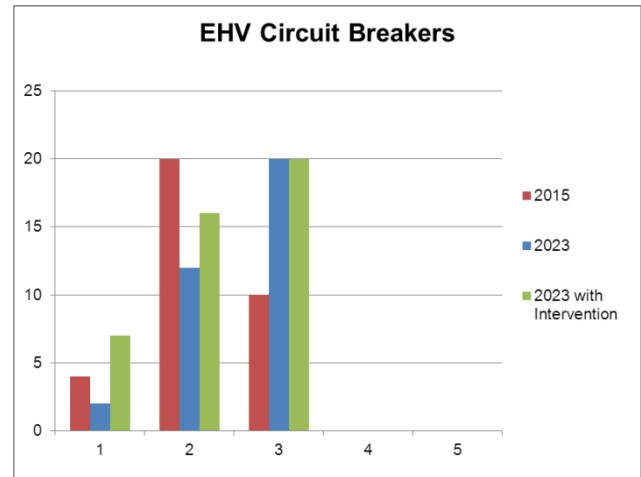
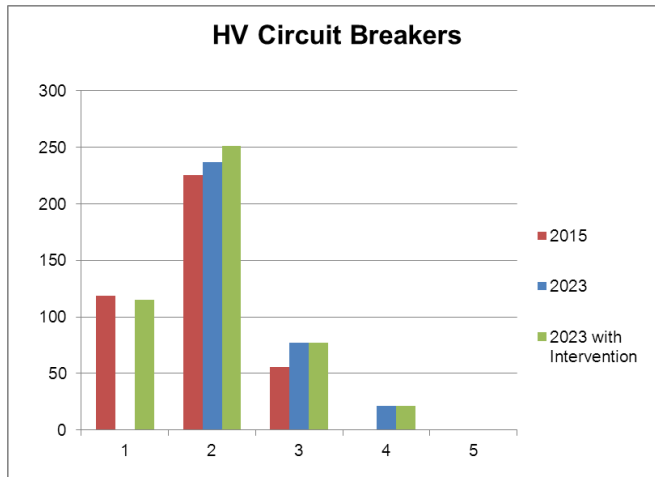


City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Output Measures – Health Index

The forecast health indices for 2015 and 2023 for each plant category, with and without intervention, are depicted in the figures below:



City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

RDP Dependencies and Assumptions

This document assumes that all DPCR5 previously approved schemes will progress as currently programmed.

The proposal for the redevelopment of Shoreditch substation is dependent on the completion of the New Cross – Finsbury Market tunnel and the installation of the associated 132kV circuits from New Cross.

Plumtree Court is dependent on the completion of Limeburner Lane substation.

The schemes covered in this RDP have been planned based on the planning load estimates dated 27/02/2013 taking into account the 2011/12 maximum demand figures. The load forecasts are based on the Element Energy model. If the economic situation improves there is a risk that there will be shortfall of reinforcement schemes in the plan.

The load forecasts also include an assumed level of embedded generation being connected to the network. Should this generation not materialise, then a larger than forecast load growth could be realised.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

2 Network Configuration

2.1 Existing Network

The network is fed from City Road 400/132kV National Grid Exit Point, which currently experiences a summer peak of 876MVA. Downstream, there is a 132kV cable network feeding predominantly 132/11kV substations and a smaller number of 132/33kV substations. These 132/33kV substations in turn feed a number of 33/11kV primary substations.

The number of UK Power Networks owned 33/11kV primary substations is expected to decrease over time as, when dictated by load growth, these are replaced with larger 132/11kV substations housed within the existing buildings (where possible) due to high land values in the area. In turn, the capacity freed up at the existing 132/33kV substations will be used to provide connections to large buildings in the city at 33kV (covered by the 33kV Distribution Network RDP). This strategy will ensure that both 11kV and 33kV load growth is catered for in the most efficient manner by utilising existing assets where possible.

The network is predominantly located in the City of London to the north of the River Thames, with the exception of Bankside Substation, which is located to the south of the Thames in Southwark and shares a building with the Tate Modern. Bankside Substation is interconnected with the network north of the Thames by an extensive tunnel network.

There is also an isolated 20kV network to the south of the Thames fed from Bankside D Substation. This network is used for new customer connections however also supports a legacy 22kV system in the area which is in the process of being phased out. There is a 22/11kV substation at Newington House (UK Power Networks Head Office) which requires work to enable it to operate with a 20kV source; and a 22/6.6kV substation at Charing Cross Railway Station, which is the only customer on this network that is located north of the Thames.

A Geographical Layout of the network can be found in Appendix A;

Single Line Diagrams of the existing network can be found in Appendix B;

A Schematic Diagram of the tunnel network in the area can be found in Appendix D.

2.2 Embedded Generation

Table 2: Embedded Generation (G59/2)

GSP	Main Substation	Customer Name (MAVIS)	SITE NAME	Installed DG (MVA)	Mode of Operation
City Road 132kV	Bankside C Total	BRITISH TELECOMMUNICATIONS PLC	COLUMBO HOUSE SOUTHBANK	5.112	Long Term Parallel
City Road 132kV	Bankside C Total	IBM UNITED KINGDOM LTD	LLOYDS COMPUTER CENTRE	10.400	Long Term Parallel
City Road 132kV	Beech Street A	CITIGEN LONDON LTD		39.500	Long Term Parallel
City Road 132kV	Devonshire Square	UBS AG	UBS	6.000	Standby
City Road 132kV	Finsbury Market A	THE TOWER MANAGEMENT SERVICE LTD	TOWER COMPLEX	6.300	Short Term Parallel
City Road 132kV	Beech Street B	CHASE MANHATTAN BANK	CHASE MANHATTAN BANK	6.800	Standby
City Road 132kV	Devonshire Square	LANDMARK PLC	JOHNSON SMIRKE BUILDING	6.000	Long Term Parallel
City Road 132kV	Finsbury Market A	CITYPOINT (JERSEY) UNIT TRUST	CITY POINT	5.200	Short Term Parallel
City Road 132kV	Paternoster	MERRILL LYNCH EUROPE PLC	MERRILL LYNCH FINANCIAL CENTRE	10.200	STANDBY
City Road 132kV	Osborn Street	INTERXION LIMITED	BLOCK B	8.000	Standby
City Road 132kV	Finsbury Market E	SIR ROBERT MCALPINE		9.600	Standby
City Road 132kV	Mansell Street 22kV		LUL GREENWICH POWER STATION	29.500	Long Term Parallel
City Road 132kV	Beech Street A	MOOR HOUSE MANAGEMENT SERVICES LTD	BNP PARIBAS, MOOREHOUSE	6.000	Standby
City Road 132kV	Osborn Street	QUEEN MARY UNIVERSITY OF LONDON	LONDON HOSPITAL (CLINICAL BLOCK)	10.000	Standby
City Road 132kV	Seacoal Lane	LAND SECURITIES GROUP PLC		5.030	Short Term Parallel
City Road 132kV	Bankside C Total	NOMURA INTERNATIONAL PLC	WATERMARK PROJECT PLACE	10.000	Standby
City Road 132kV	City Road B	LEVEL 3 COMMUNICATIONS LTD	LEVEL 3 COMMUNICATIONS LTD	15.200	Standby
City Road 132kV	City Road B	LEVEL 3 COMMUNICATIONS LTD	LEVEL 3 COMMUNICATIONS LTD	15.200	Standby

Note: CITIGEN generators are currently out of service and may be taken offline permanently.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

The total installed capacity of G59/2 embedded generation under this RDP is 258MW. Table 3 above details all the generating plants used in the analysis for the City Road Network with an installed capacity of over 5MVA (totalling 204MVA).

2.3 Projects in Progress

2.3.1 Limeburner Lane: Establish New 132/11kV Substation

Seacoal Lane Substation is contained in the basement of Seacoal House, located within ¼ mile of Blackfriars and the Old Bailey Law Courts in the City of London. The building was a disused ex-LEB, 7-storey office and has recently been demolished to ground floor level and rebuilt to accommodate network reinforcement.

Due to a change in the road layout historically surrounding the substation, it is now situated on Limeburner Lane. The substation is therefore being renamed as part of the redevelopment.

Seacoal Lane Substation currently consists of a 44-panel, double busbar, 11kV switchboard only. The switchboard consists of three sections:

Section 1: Reyrolle C manufactured in 1954 → 9 x Feeders, 2 x Incomers, 1 x Bus Coupler, 1 x Bus Section

Section 2: Alstom WBD manufactured in 2006 → 10 x Feeders, 4 x Incomers, 4 x Off Load Disconnectors

Section 3: Reyrolle C manufactured in 1954 → 10 x Feeders, 1 x Incomer, 1 x Bus Coupler, 1 x Bus Section

It is supplied via 7x11kV, 630mm², copper, XLPE circuits running through the City Road – Farringdon – Seacoal Lane tunnel. These circuits have a firm rating of 65.2MVA and due to their length and heavy loading, are the primary heat source and therefore use up the majority of the thermal capacity available within the tunnel.

Both City Road C and the circuits feeding Seacoal Lane are currently out of firm (LI4), with P2/6 compliance maintained via the post-fault transfer of the Seacoal Lane SW Feeder Group (19MVA) to Paternoster Substation. Paternoster's switchboard has recently been partially transferred to Bankside C to maintain P2/6 compliance and to free up 33kV capacity at Finsbury Market C for new connections to the City of London 33kV Distribution Network.

Limeburner Lane 3x66.6MVA, 132/11/11kV substation is currently under construction, with completion expected in Q4 2015. The substation is to be supplied via a loop in/out arrangement from existing 132kV cables installed in the City Road to Bankside deep cable tunnel.

The new substation will have a summer firm rating of 172MVA due to the transformers being specified as having a 130% cyclic rating for a 12-hour period with an ambient air temperature of 300°C.

The drivers for the project are as follows:

- Maintain P2/6 compliance at City Road C/Seacoal Lane
- Free up 11kV capacity near to the City Road Basin development and regeneration hub
- Free up space and thermal capacity in the Back Hill – Farringdon tunnel for circuits associated with the City of London 33kV Distribution Network (see 33kV Distribution Network RDP)
- Provision for 11kV switch positions for surrounding connections activity

The scope of work is as follows:

- Cap the existing deep tunnel shaft and remove ventilation (forced exit)
- Demolish the existing 7-storey building to ground floor level
- Rebuild a fit for purpose structure and substation ventilation scheme

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

- Reinstall the tunnel ventilation scheme
- Install 3x132kV GIS H-points with inline breakers
- Install 3x132/11kV, 66.6MVA transformers
- Install 6x132kV circuits from the existing 3xCity Road – Bankside 132kV Circuits to loop in/out of the new GIS tee points via the Deep Tunnel and Limeburner Lane Shaft
- Install a new 41-panel 11kV switchboard in 2 sections and interconnect to the existing Alstom WBD switchgear, which is to be retained
- Remove the existing 26 panels of Reyrolle C switchgear (HI4)

2.3.2 Plumtree Court - 11kV Switchboard Extension

Goldman Sachs have requested a 10MVA supply for a site known as Plumtree Court. During the negotiations between UK Power Networks Connections and the customer it was agreed that the customer would provide space for a larger switchboard than they required to be installed.

A 31-panel double busbar 11kV, 2500A, switchboard has been proposed (subject to customer acceptance) as per the single line diagram shown in Figure 1 below:

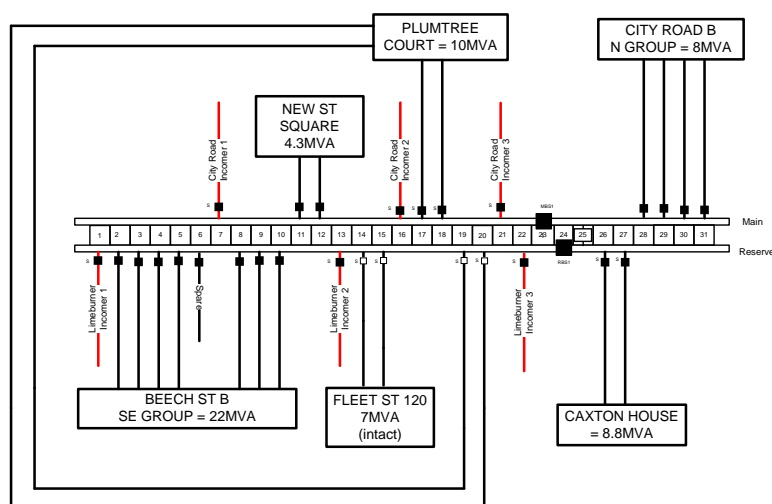


Figure 1: Plumtree Court Single Line Diagram

The incoming feeders will be provided by cutting into the existing City Road C – Seacoal Lane 11kV circuits running through the tunnel system, using two cables per phase in order to retain thermal capacity within the tunnel. This project is therefore dependent on the completion of Limeburner Lane.

The drivers for the project are as follows:

- The Beech Street B South East Feeder Group is overloaded. There are no spare switches and no space for expansion at the substation. In addition, the first legs of this group are approximately 1,700m in length. The group is geographically located close to the Plumtree Court site and the project will facilitate reinforcement of this feeder group.
- City Road B MSS is approaching firm capacity with a high number of connections referrals allocated. The site is heavily reliant on emergency post-fault transfers to maintain compliance. This site is also geographically close to the Plumtree Court site and the project will facilitate reinforcement of this feeder group.
- New St Square, 1 – The customer requires a 4.3MVA Solkor connection from the 11kV network. If the customer were connected to Limeburner Lane MSS, this would utilise two switches and be an inefficient use of the capacity installed at Limeburner Lane.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

- Caxton House – Due to the size of the load required (8.8MVA), if it were to be connected to Limeburner Lane, it would require the addition of feeders into any existing group or dedicated switches. As the location of Caxton House is better suited to a connection at Plumtree Court, it has been deemed a more appropriate point of connection.
- Fleet St, 120 – This customer is to be supplied from Bankside, but have requested a backup “intact only” supply from an alternative substation. Again, so as to not underutilise switches at Limeburner Lane, the alternative supply has been assigned to Plumtree Court.

2.3.3 Calshot Street: Establish 2x66MVA 132/11kV Substation

Calshot Street is a UK Power Networks’ leasehold site strategically located 500m east of London Kings Cross railway station. In 1978, London Borough of Islington granted London Electricity Board an 80-year lease of the site. In 1999, Peabody Trust took over ownership of the site.

As the site has not been in continuous use for ‘operational purposes’, it is not possible to make use of permitted development rights and a full planning application is required.

Two existing 132kV, 630mm² Aluminium Conductored, XLPE insulated circuits, which feed Canal Street MSS, pass within 100m of the Calshot Street site. Since Canal Street is contracted for a maximum demand of 45MVA, there is capacity in the circuits to connect a 2x66MVA 132/11kV primary substation. The ‘N-1’ summer cyclic rating of the circuits is 152MVA.

The establishment of Calshot Street Main Substation allows load to be transferred from Back Hill A 11kV and City Road B 11kV (both LI4). The load on Back Hill A 11kV exceeds the firm capacity of the substation, with Engineering Recommendation P2/6 compliance maintained via 11kV post-fault transfers. City Road B 11kV currently has circa 17MVA of spare capacity available but also has 38MVA (diversified at 0.8) of connection applications allocated to it.

As well as relieving loading issues in the surrounding network, this new Main Substation will provide spare 11kV circuit breakers. These spare breakers give flexibility to the surrounding network and also allow timely connection of new HV customers. There has been an informal expression of interest for an 8MVA supply to Euston Station with N-3 security for the High Speed 2 rail project as well as an additional 7.5MVA traction supply.

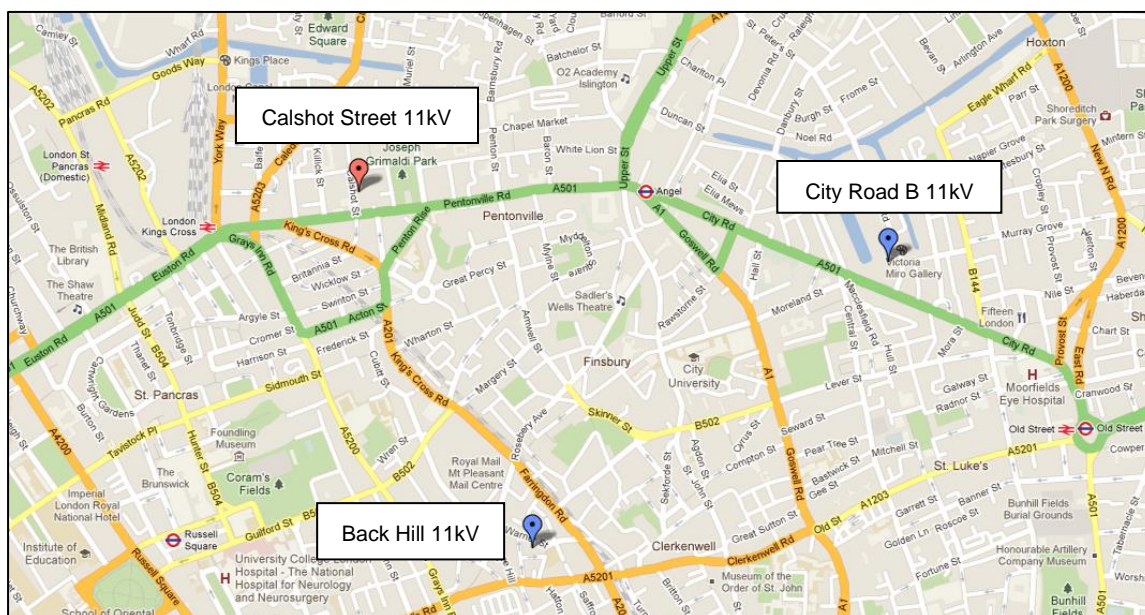


Figure 2: Calshot Street – Map of Associate Substations

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

2.3.4 Back Hill 11kV: South Group Transfer to Fisher Street

It is proposed to transfer the South Group permanently from Back Hill 11kV to Fisher Street. This project will allow Back Hill 11kV to remain P2/6 compliant and will be undertaken once Fisher Street substation is upgraded to a 132/11kV site creating 36MVA of additional capacity. The South Group at Back Hill represents around 25MVA of capacity.

2.3.5 Permanent Transfer of Beech St B SE Group to Plumtree Court New Switchboard

The Beech Street South East Group is at firm capacity whilst the demand at Beech Street B main substation is approaching the firm capacity limit. As there are no spare switches and no way out of the main substation for additional circuits, it is proposed to reinforce and transfer the SE Group to Plumtree Court new switchboard. This project is therefore dependent on timely completion of the switchboard extension at Plumtree Court.

2.3.6 Finsbury Market: Deep Cable Tunnel Extension

To enable development of the City of London intermediate voltage network, it is proposed to construct a short extension (60m) to the new New Cross – Finsbury Market deep cable tunnel to establish viable routes for distribution feeder groups connecting to the site. Open-cut route proving confirmed severe street service congestion to the west of Finsbury Market substation hence this option was discarded.

2.3.7 Cost Phasing for Projects in Progress

Table 3: Ongoing Projects (NAMP 19th February 2014)

Cat.	Reference	Description	2013/14	2014/15	2015/16	2016/17	2017/18
R	1.33.03.8471	Plumtree Court - 11kV Switchboard Extension	0	180,084	540,252	0	0
R	1.34.01.5743	Back Hill 11kV: South Group Transfer to Fisher Street	402,183	861,823	517,095	0	0
R	1.34.02.5884	Permanent Transfer of Beech St B SE Group to Plumtree Court New Switchboard	0	64,005	256,018	192,014	0
R	1.35.01.2632	Limeburner Lane: Establish new 132/11kV Substation	8,965	713	42	0	0
R	1.35.07.5795	Calshot Street: Establish 2x66MVA 132/11kV Substation	152,832	258,325	5,658,214	1,410,363	0
R	1.37.09.4379	Finsbury Market: Deep Cable Tunnel Extension	2,525,532	0	0	0	0

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

3 Network Development Considerations

3.1 Development Areas

Elephant & Castle – Heygate Estate: Outline Planning Permission granted for 2,500 new homes (circa 5MVA of load diversified at 2kVA per household).

Islington – City Road Basin urban development: Situated in one of London’s most fashionable and cosmopolitan districts, the freehold of 8.5 acres of land surrounding the Islington Canal basin is to be transformed into a waterside residential quarter with restaurants and shops and a new public civic space.

- 259 City Road: A planning consent was granted in April 2010 for the erection of a 29-storey tower comprising 300 residential units and ground floor commercial floor space. Work has now started on site.
- 261 City Road: An application was approved in December 2006 for the erection of 36-storey building (Islington’s tallest residential tower) and two 8-storey buildings to provide a total of 307 residential units. The development will feature 785 square metres of mixed-use commercial floor space. Construction launches in spring 2014.

Figure below depicts the proposed development at the City Road Basin with the construction of two residential towers.



Figure 3: City Road Basin Proposed Development

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

3.2 HI Profile – Without Intervention

Table 4: HV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH ST A	1	7	5				1	12		
BEECH ST B	19	37					56			
CITY RD B 11KV	8	48					54	2		
CITY RD C 11KV	21						21			
DEVONSHIRE SQ		54					24	30		
FINSBURY MKT A 11KV		5	23				1	6	21	
FINSBURY MKT D 11KV		14					14			
FINSBURY MKT E 11KV	63	3					66			
OSBORN ST		27								
PATERNOSTER		21	6					27		
SEACOAL LANE 11KV	7	9	22							

Table 5: EHV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
FINSBURY MARKET B 33KV	1	4	10				1	14		
FINSBURY MARKET C 33KV	1	12					7	6		
HOXTON 33KV	2					2				
MANSELL ST (LUL) 22KV		4					4			

Table 6: 66 and 132kV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
CITY ROAD 132KV	1	19					15	5		
SHOREDITCH 66KV		1		5			1			5

Table 7: Primary Transformers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH ST A		2						2		
FINSBURY MKT A 11KV		1						1		
FINSBURY MKT D 11KV		3					1	2		
OSBORN ST		4								
PATERNOSTER		1						1		

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Table 8: Grid Transformers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH STREET B		3					3			
CANAL STREET	2					2				
CITY ROAD B 11KV		1	1						2	
CITY ROAD C 11KV	1			1			1			1
DEVONSHIRE SQ		3							1	2
FINSBURY MARKET B 33KV		1	1	1				1	1	1
FINSBURY MARKET C 33KV			1	2				1		2
FINSBURY MKT A 11KV			2	1					2	1
FINSBURY MKT E 11KV	1	2					3			
HOXTON 33KV	1					1				
MANSELL ST (LUL) 22KV		2					2			

Table 9: Fluid Filled Cables

Cable Route	Cable Section	Voltage kV	2015 HI	2023 HI
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-1-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-2-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-3-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-4-A	33	2	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-1-A	33	3	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-2-A	33	2	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-3-A	33	2	2
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-4-A	33	2	2
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-1-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-2-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-3-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-4-A	33	2	3

Notes: Osborn Street will be replanted at 132kV and fed from New Cross GSP. The new Limeburner Lane substation will replace Seacoal Lane switching station.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

3.3 Security of Supply Analysis

Table 10: P2/6 Assessment Table

Substation	P2/6	Type of substation	Secondary Voltage	Firm Capacity (MW)	Transfer (MW)	P. F.	Winter 13/14 Summer 2013 (MW)	Winter 14/15 Summer 2014 (MW)	Winter 15/16 Summer 2015 (MW)	Winter 16/17 Summer 2016 (MW)	Winter 17/18 Summer 2017 (MW)	Winter 18/19 Summer 2018 (MW)	Winter 19/20 Summer 2019 (MW)	Winter 20/21 Summer 2020 (MW)	Winter 21/22 Summer 2021 (MW)	Winter 22/23 Summer 2022 (MW)
Back Hill 33kV	YES	Grid	33kV	149.90		0.94	107.90	125.77	89.86	116.58	117.72	119.94	120.58	121.25	121.98	122.73
Back Hill 33kV	YES	Grid	33kV	116.10	21.38	0.86	109.56	127.45	90.91	118.39	119.52	121.73	122.36	123.01	123.72	124.45
Back Hill	YES	Grid	11kV	54.90		0.96	43.49	44.14	20.56	3.83	4.13	4.45	4.78	5.11	5.49	5.89
Back Hill	NO	Grid	11kV	42.75	1.26	0.95	44.64	45.27	20.46	3.72	4.01	4.31	4.62	4.93	5.30	5.67
Bankside C	YES	Grid	11kV	229.90		0.95	130.99	133.95	69.94	72.35	75.10	77.95	50.38	53.40	56.75	60.19
Bankside C	YES	Grid	11kV	222.60		0.92	125.71	128.45	66.96	69.20	71.74	74.38	39.25	42.04	45.14	48.33
Bankside C Total	YES	Grid	11kV	229.90		0.95	130.99	133.95	136.94	139.35	142.10	144.95	117.38	120.40	123.75	127.19
Bankside C Total	YES	Grid	11kV	222.60		0.92	125.71	128.45	131.21	133.45	135.99	138.63	103.50	106.29	109.39	112.58
Bankside D	YES	Grid	20kV	105.60		0.96	32.00	56.97	27.75	28.02	28.32	28.64	28.96	29.29	29.71	30.13
Bankside D	YES	Grid	20kV	101.20		0.92	35.96	57.74	27.57	27.84	28.15	28.46	28.79	29.12	29.53	29.96
Bankside D 20kV Group	YES	Group Load	20kV	117.00		0.96	29.35	29.35	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
Bankside D 20kV Group	YES	Group Load	20kV	117.00		0.96	33.68	33.68	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18
Bankside F	YES	Grid	132kV	263.40		0.96	181.53	209.04	62.65	64.99	67.66	70.42	73.27	76.19	79.49	82.87
Bankside F	YES	Grid	132kV	263.40		0.96	227.11	252.06	77.29	80.13	83.38	86.73	90.18	93.73	97.72	101.82
Beech Street A	YES	Primary	11kV	18.72		0.96	8.87	9.06	9.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beech Street A	YES	Primary	11kV	14.10		0.94	9.61	9.81	10.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beech Street B	YES	Grid	11kV	154.17		0.98	78.43	79.62	80.82	81.78	82.89	84.03	85.22	86.43	87.78	89.16
Beech Street B	YES	Grid	11kV	127.68		0.95	94.18	95.54	96.91	98.01	99.27	100.58	101.93	103.32	104.85	106.43
Brick Lane	NO	Customer	33kV	0.00		0.96	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Brick Lane	NO	Customer	33kV	0.00		0.96	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Calshot Street	YES	Grid	11kV	82.40		0.96	0.00	0.00	0.00	47.10	47.10	47.10	47.10	47.10	47.10	47.10
Calshot Street	YES	Grid	11kV	63.40		0.96	0.00	0.00	0.00	45.40	45.40	45.40	45.40	45.40	45.40	45.40
Canal Street	YES	Grid	11kV	74.90		0.96	15.65	22.85	22.85	22.85	22.85	22.85	22.85	22.85	22.85	22.85
Canal Street	YES	Grid	11kV	55.20		0.92	14.56	21.24	21.24	21.24	21.24	21.24	21.24	21.24	21.24	21.24
Charing Cross 6.6kV	YES	Primary	6.6kV	6.70		0.96	2.72	2.72	2.72	2.72	2.72	2.72	2.72	2.72	2.72	2.72
Charing Cross 6.6kV	YES	Primary	6.6kV	5.50		0.92	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Charterhouse Street Citigen	YES	Customer	11kV	40.00		0.96	12.40	12.40	12.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Charterhouse Street Citigen	YES	Customer	11kV	40.00		0.92	12.41	12.41	12.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City Rd Seacoal Bankside F Group	YES	Group Load	132kV	479.80		0.96	197.51	232.22	169.37	218.81	221.49	224.25	227.09	230.02	233.31	236.70
City Rd Seacoal Bankside F Group	YES	Group Load	132kV	459.80		0.92	241.67	273.29	200.04	248.28	251.53	254.88	258.33	261.88	265.87	269.97
City Road 132kV	YES	GSP	132kV	1244.16		0.96	821.29	861.79	688.55	713.96	705.49	713.57	721.85	729.36	737.84	746.53
City Road 132kV	YES	GSP	132kV	1099.00		0.96	901.77	939.56	740.60	757.93	754.18	763.01	772.07	780.37	789.70	799.27
City Road B	YES	Grid	11kV	149.45		0.95	115.28	116.83	118.42	93.51	94.98	96.51	98.08	99.69	101.60	103.54
City Road B	YES	Grid	11kV	123.65		0.92	105.53	106.88	108.27	83.20	84.48	85.81	87.18	88.59	90.25	91.95
City Road C	YES	Grid	11kV	75.50		0.96	53.05	53.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City Road C	YES	Grid	11kV	63.25	2.40	0.92	63.67	63.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
City Road to Finsbury Circuits	YES	Circuits	132kV	296.30		0.96	216.58	217.83	180.04	178.68	162.51	162.67	162.83	162.99	163.17	163.36
City Road to Finsbury Circuits	YES	Circuits	132kV	260.80		0.92	234.06	235.38	193.96	185.60	173.44	173.60	173.77	173.95	174.14	174.34
Devonshire Square	YES	Grid	11kV	151.00		0.96	87.16	88.81	90.47	91.82	93.35	94.93	96.56	98.24	100.09	101.99
Devonshire Square	YES	Grid	11kV	126.34		0.94	93.02	94.70	96.38	97.75	99.30	100.91	102.56	104.26	106.14	108.07
Finsbury Market A	YES	Grid	11kV	55.40		0.96	35.26	35.27	35.29	35.30	35.31	35.32	35.34	35.35	35.37	35.38
Finsbury Market A	YES	Grid	11kV	42.30	6.27	0.94	40.06	40.07	40.09	40.10	40.11	40.13	40.14	40.16	40.18	40.20
Finsbury Market B 33kV	YES	Grid	33kV	108.81		0.93	75.32	75.94	41.06	41.24	41.44	51.50	91.60	92.46	93.42	94.41
Finsbury Market B 33kV	NO	Grid	33kV	80.10	15.08	0.89	75.00	75.55	37.02	37.13	37.26	48.32	97.06	97.83	98.69	99.57
Finsbury Market C 33kV	YES	Grid	33kV	111.15		0.95	36.73	37.01	37.29	37.52	37.78	28.21	19.44	19.44	19.44	19.44
Finsbury Market C 33kV	YES	Grid	33kV	81.00		0.90	35.28	35.56	35.83	36.05	36.31	25.66	15.50	15.50	15.50	15.50
Finsbury Market D	YES	Primary	11kV	37.44		0.96	17.33	17.34	17.34	17.35	17.35	17.36	17.36	17.37	17.38	17.38
Finsbury Market D	YES	Primary	11kV	27.60		0.92	19.87	19.88	19.88	19.89	19.89	19.90	19.91	19.91	19.92	19.93
Finsbury Market E	YES	Grid	11kV	167.86		0.97	81.35	81.50	81.64	81.76	81.90	82.03	82.18	82.32	82.48	82.65
Finsbury Market E	YES	Grid	11kV	138.97		0.94	91.67	91.82	91.98	92.11	92.25	92.40	92.56	92.71	92.89	93.07
Hoxton	N/A	Customer	33kV	86.40		0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hoxton	N/A	Customer	33kV	57.60		0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Limeburner Lane	YES	Grid	11kV	166.23		0.96	0.00	0.00	83.55	83.55	83.55	83.55	83.55	83.55	83.55	83.55
Limeburner Lane	YES	Grid	11kV	159.30		0.92	0.00	0.00	101.51	101.51	101.51	101.51	101.51	101.51	101.51	101.51
Mansell Street 22kV LUL	N/A	Customer	22kV	82.45		0.97	38.38	38.38	38.38	38.38	39.38	40.38	41.38	41.38	41.38	41.38
Mansell Street 22kV LUL	N/A	Customer	22kV	78.20		0.92	37.70	37.70	37.70	37.70	38.70	39.70	40.70	40.70	40.70	40.70
Newington House.	YES	Primary	11kV	37.80	15.03	0.97	0.00	24.97	25.30	25.57	25.87	26.19	26.51	26.85	27.26	27.69
Newington House.	YES	Primary	11kV	27.90		0.93	0.00	21.78	22.12	22.38	22.69	23.01	23.33	23.66	24.08	24.51
Osborn Street	YES	Primary	11kV	55.58		0.95	37.92	38.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Osborn Street	YES	Primary	11kV	41.40	8.81	0.92	41.50	41.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paternoster	YES	Primary	11kV	58.20		0.97	8.31	8.41	8.50	8.58	8.67	8.77	0.00	0.00	0.00	0.00
Paternoster	YES	Primary	11kV	57.60		0.96	9.64	9.75	9.86	9.95	10.05	10.16	0.00	0.00	0.00	0.00
Paternoster.	YES	Primary	11kV	56.70		0.97	0.00	0.00	0.00	0.00	0.00	0.00	39.70	40.14	40.63	41.13
Paternoster.	NO	Primary	11kV	43.20		0.96	0.00	0.00	0.00	0.00	0.00	0.00	48.43	48.87	49.36	49.86
Toohey St via Bankside	YES	Grid	11kV	37.40		0.96	22.24	22.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Toohey St via Bankside	YES	Grid	11kV	28.80		0.96	25.94	25.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Whiston Road T1	YES	Primary	11kV	15.00	5.27	0.96	15.72	15.93	16.14	16.32	0.00	0.00	0.00	0.00	0.00	0.00
Whiston Road T1	YES	Primary	11kV	14.00		0.94	11.90	12.05	12.20	12.33	0.00	0.00	0.00	0.00	0.00	0.00

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Table 10 above is the P2/6 assessment table which shows the load growth predicted on the City Road network (demand exceeding the substation firm capacity plus any available post-fault transfer capability is highlighted in orange).

With the exception of Back Hill 11kV, all sites that face firm capacity issues due to projected load growth or other local factors are currently/will remain P2/6 compliant within ED1 via the available 11kV post-fault transfers or the proposed interventions covered in this RDP. Following the completion of the proposed reinforcement schemes (see details below), additional load transfer capacity will be made available between Finsbury Market B & C 33kV ensuring that Finsbury Market B will remain compliant with P2/6.

Paternoster substation was a 4x15MVA 33/11kV substation until 2012 when 3 of the transformers were decommissioned and it is currently fed via 1x15MVA 33/11kV transformer (from Finsbury Market C 33kV) and 3x11kV circuits (from Bankside C; each rated at 20MVA). The firm capacity of the substation in the above table is based on the minimum available capacity on those three interconnectors following the loss of the single 33/11kV transformer. After 2019 Paternoster will be reconfigured to its initial state and the 3x11kV circuits from Bankside C will be partially utilised for other purposes; hence the firm capacity is then based on a 4x15MVA transformer site (refer to 4.2.3 & 4.2.4). The site is expected to continue to comply with ER P2/6 until the end of ED1 relying on the interconnection to Bankside C; the 11kV load transfer capacity post-intervention will be established nearer the time.

Since there is insufficient post-fault transfer capability, the summer maximum demand at Back Hill 11kV substation will be exceeding the site firm capacity until 2015, when Fisher Street will be replanted at 132kV enabling Back Hill 11kV to be deloaded. It is recommended that an 'At Risk' study is carried out to determine the summer cyclic capability of the Back Hill transformers and if necessary a derogation application submitted to Ofgem on the grounds that any interim investment to deal with this issue would be an inefficient use of capital.

The 2015 and 2023 Load Index per substation, should no interventions be made, is shown below:

Table 11: Load Index per Substation (Without Intervention)

Substation	Voltage kV	Load Index	
		2015	2023
Beech Street A	33/11	1	2
Beech Street B	132/11	1	2
City Road B	132/11	2	3
City Road C	132/11	4	5
Devonshire Square	132/11	1	2
Finsbury Market A	132/11	2	3
Finsbury Market B 33kV	132/33	4	5
Finsbury Market C 33kV	132/33	1	1
Finsbury Market D	33/11	1	1
Finsbury Market E	132/11	1	1
Osborn Street	33/11	4	5
Paternoster	33/11	1	1
Tooley St via Bankside	132/11	2	2
Bankside C Total	132/11	1	2
Bankside D	132/20	1	1

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

3.4 Operational and Technical Constraints

- 1) There will be 62MVA of spare capacity available at Limeburner Lane Substation upon completion; however open-cut cable routes to the west of the substation are not feasible due to the barrier created by the Thameslink Railway Line. The City Road – Bankside tunnel system is the only route out in this direction via an intermediate shaft in Farringdon Road. Space and thermal constraints in the City Road – Limeburner Lane tunnel need to be carefully managed at this network critical pinch point.
- 2) The Finsbury Market C – Beech Street A – Paternoster 33kV fluid filled cables have a historically high leak rate, with the Beech Street A – Paternoster section being in the worst 8% in the LPN area, averaging 4,945 litres leaked per annum over the last decade. Recent repair work and deloading due to a temporary load transfer from Paternoster to Bankside has seen this figure drop to 425 litres in 2012. The Finsbury Market C – Beech Street A section is less urgent, with an average leak rate of 421 litres per annum over the past decade.
- 3) The following 11kV feeder groups are on the Distribution Planning Hotspots List and are considered in this document to identify synergies with the substation reinforcement needs of the area:
 - Seacoal Lane NS Group – Load will exceed N-1 firm capacity once already connected load ramps up to its notified maximum demand
 - Paternoster NE Group – Feeder NE1 overloaded during a recent hot spell. This Solkor group shares load unequally and needs to be reinforced
 - City Road B NE Group – There are a large amount of connections referrals allocated to this feeder group. This will see the group fully loaded if these proceed. Reinforcement options are to be investigated
 - City Road B N Group – Cable sections overloaded for an outage on feeder N4
 - Beech Street B SE Group – Small section conductor sections on feeders SE1 and SE5 overloaded
- 4) The following transformer replacement works need to be considered in conjunction with the reinforcement needs for the area:
 - One of the four Paternoster 33/11kV transformers will require replacement due to condition in ED1
 - Two of the City Road B 132/11kV transformers will require replacement due to condition in ED1
 - One of the City Road C 132/11kV transformers will require replacement due to condition in ED1
- 5) The following switchgear is overstressed:

Table 12: Overstressed Switchgear

Substation	Node Name	Voltage Level	System		Existing		Fault Rating	
			R	X	Peak Make	RMS Break	Peak Make	Break
		kV	% on 100 MVA		kA	kA	kA	kA
Finsbury Market B 33kV	FINB31	33	1.66	10.59	41.43	14.69	32.8	13.1
Finsbury Market C 33kV	FINC31	33	1.48	11.41	39.05	14.27	32.8	13.1

Note: The Finsbury Market C Switchgear is currently being replaced under scheme 5550 (covered in the 33kV Distribution Network RDP) which will resolve the fault level issue shown in the table above. The Finsbury Market B fault level issue will be addressed as part of project 6135 (see 4.1.1 below).

- 6) The City Road – Finsbury Market 132kV circuits are in violation of Engineering Recommendation P18 – Complexity of 132kV Circuits. Restriction B states that “Not more than three transformers shall be banked together on any one circuit at any one site”. However, Finsbury Market has four banked transformers on site (Substations A, B, C & E). Furthermore, these circuits are then double banked with Devonshire Square and Hoxton transformers back at City Road GSP.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

- 7) A schematic diagram of the existing City Road – Bankside tunnel can be found in Appendix D. While the construction of this tunnel has been necessary to provide a means of capacity injection into the City of London, it has also created a critical network operational and technical constraint.

The worst conceivable event would be a fire near the Farringdon – Limeburner Lane spur tunnel section. This would result in the loss of 251MW of load, of which only 52MW can be restored from alternative sources:

Table 13: Load at Risk for Tunnel HILP Event

Substation	Loading (MW)	Transferable (MW)	Load Lost (MW)
Limeburner Lane	102	0	102
Paternoster	11	0	11
Bankside C	36	0	36
CoL 33kV Network	45	45	0
Plumtree Court	57	7	50
Total	251	52	199

3.5 National Grid

An application is to be made for a 4th SGT at New Cross 132kV GSP to maintain (N-2) P2/6 compliance. A UK Power Networks funded extension to the switchhouse will be required to accommodate National Grid's 132kV circuit breaker. This project is covered in detail in the New Cross RDP.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

4 Recommended Strategy

4.1 Asset Replacement

4.1.1 Finsbury Market B Install 33kV Auto Close Scheme

Finsbury Market B comprises 3x45MVA 132/33kV transformers which exceed the fault rating of network switchgear when operated in parallel. This switchgear is Reyrolle L42, which is known to have capabilities in excess of its nameplate rating data. However, Network Operations have been informed of the issue and are currently managing the safety risk by imposing an access restriction on the above switchrooms.

Should any personnel be required to enter these switchrooms, then the network is first remotely switched so that only two of the three transformers are run in parallel, thereby reducing the fault level to within the switchgear limitations.

To increase utilisation of the transformer capacity and remove operational constraints it is proposed to install a 33kV auto-close scheme. Normal operation would be to run 2 transformers in parallel with the 3rd supplying a separate section of busbar. For the loss of a transformer the section and coupler circuit breakers would close. The recommendation is therefore to tolerate the situation and manage the risk via access restriction until the above projects are completed.

4.1.2 Finsbury Market B 33kV - Replace Grid Transformers (GT1B, GT2B, GT3B)

The condition assessment of the 1955/56/62 Fuller Electric 45MVA Grid Transformers with Brush HD/HS tap changers installed at Finsbury Market B 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends their replacement. Completion of the project will see 3 Grid Transformers replaced with 3 new 45MVA Grid Transformers.

4.1.3 City Road C 11kV - Replace Grid Transformer (GT3)

The condition assessment of the 1980 Ferranti 60MVA Grid Transformer with Ferranti FC6 tap changer installed at City Road C 132/11kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable (HI5 at the end of ED1). It is not possible to keep this asset in use without compromising operational requirements; therefore this project recommends its replacement. Completion of the project will see 1 Grid Transformer replaced with 1 new 60MVA Grid Transformer.

4.1.4 Finsbury Market A 11kV - Replace Grid Transformer (GT2A)

The condition assessment of the 1961 Ferranti 15MVA Grid Transformer with Ferranti FC4 tap changer installed at Finsbury Market A 132/11kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable (HI5 at the end of ED1). It is not possible to keep this asset in use without compromising operational requirements; therefore this project recommends its replacement. Completion of the project will see 1 Grid Transformer replaced with 1 new 15MVA Grid Transformer.

4.1.5 Paternoster - Replace Primary Transformer (T4)

The condition assessment of the 1966 Ferranti 15MVA Primary Transformer with Ferranti DC3 tap changer installed at Paternoster 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable (HI5 at the end of ED1). It is not possible to keep this asset in use without

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

compromising operational requirements; therefore this project recommends its replacement. Completion of the project will see 1 Primary Transformer replaced with 1 new 15MVA Primary Transformer.

4.1.6 Finsbury Market A 11kV - Refurbish Grid Transformers (GT1A, GT3A)

The condition assessment of the 1961/62 Ferranti Grid Transformers with Ferranti FC4 tap changers installed at Finsbury Market A 132/11kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable (HI4 at the end of ED1). It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends their refurbishment. Completion of the project will see 2 Grid Transformers refurbished. As aforementioned, GT2A will be replaced due to asset condition.

4.1.7 City Road B 11kV - Refurbish Grid Transformers (GT1, GT2)

The condition assessment of the 1979 Ferranti Grid Transformers with Ferranti FC6 tap changers installed at City Road B 132/11kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable (HI4 at the end of ED1). It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends their refurbishment. Completion of the project will see 2 Grid Transformers refurbished.

4.2 Reinforcement

4.2.1 Ludgate Circus: Establish 11kV Site

Due to organic load growth and small connections activity in the Central London areas bordered by Bankside C, South Bank, Seacoal Lane 11kV (Limeburner Lane), Paternoster and City Road substations; a significant number of the 11kV feeder groups are approaching their capacity during periods of peak demand and hot spells with some of them exceeding their firm capacity. The 11kV network in the area will need to be reinforced to ensure continued security of supply whilst meeting customer power requirements within acceptable timescales. 11kV feeder panels to reinforce the interconnected feeder groups would have to be derived from the existing substations but these sites are space constrained which restricts the ability to install additional panels to enable the required reinforcement. The new Limeburner Lane 132/11kV Substation (a replacement for Seacoal Lane 11kV) will have 58MVA spare capacity available in summer on completion of the reinforcement project currently underway (Project 2632); however open-cut cable routes to the west of the substation are unfeasible due to the barrier created by the Thameslink Railway Line. The City Road-Bankside tunnel system is the only route out in this direction via an intermediate shaft in Farringdon Road. Bankside C 132/11kV Substation has 100MVA spare capacity available in summer. Space and thermal constraints in the City Road-Limeburner Lane tunnel need to be carefully managed at this network critical pinch point and this requires limiting the number of 11kV circuits installed in the tunnel.

This scheme allows for the civil modifications (required to avoid safety issues and further degradations of the site resulting from trespassers or water ingress) of the Ludgate Circus toilet block in preparation of the proposed establishment of a new 25-panel 11kV satellite switchboard fed from Limeburner Lane (via Seacoal-Farringdon high level tunnel) and Bankside C (via Blackfriars Bridge). The close proximity of the intermediate shaft in Farringdon Road and accessibility of Ludgate Circus via public roads significantly reduces the complexity and risks of establishing new 11kV circuits to reinforce the existing network. Installation of this satellite switchboard allows capacity from Limeburner Lane and Bankside C to be relocated to an area with limited capacity headroom thereby facilitating the required network reinforcement. Installation of the 25-panel 11kV switchboard will be under a different scheme in ED2 when the network needs to be reinforced.

Completion of this project will see a modified Ludgate Circus site ready to accept a new 25-panel, 2500A rated, 11kV single busbar switchboard in early ED2.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

4.2.2 11kV Load Transfers to Calshot Street MSS

This project covers the 11kV load transfers associated with the new Calshot Street Substation (Section 2.3.3) in order to deload Back Hill A 11kV (out of firm) and City Road B (to create capacity for existing connection referrals).

Transferring the Back Hill A North group directly to Calshot Street has been analysed and is considered uneconomical due to high excavation costs. An alternative solution involves transferring load from Longford Street to Calshot Street and then from Back Hill A to Longford Street.

The following permanent 11kV transfers will be made:

- Calshot Street substation will receive approximately 26MVA from City Road B (NW group), 1.2MVA from City Road B (SP group) and 22MVA from Longford St (East group)
- Longford Street will receive circa 18MVA from Back Hill A (North group)

4.2.3 Paternoster 33/11kV - Reconfiguration to Finsbury Market B (33kV Circuits)

Upon completion of the Osborn Street project (establish new Osborn Street B 132/11kV substation – 2622; details can be found in the New Cross RDP) capacity headroom will be available at Finsbury Market B. By transferring Osborn Street from City Road to New Cross and installing a single switch mesh at Finsbury Market 132kV (project 5591; New Cross RDP) there will be increased capacity in the City Road – Finsbury Market 132kV circuits. It is therefore proposed to reconfigure Paternoster to be supplied from Finsbury B. This will release capacity at Bankside C and will allow the 11kV circuits currently feeding Paternoster from Bankside C via the tunnel system to be partially reused to facilitate the replanting of Shorts Gardens substation (project 2635; New Cross RDP). The interconnection to Bankside C will continue to provide post-fault support which will ensure compliance with ER P2/6.

Completion of this project will see the re-commissioning of three of the four 33kV circuits between Finsbury Market and Paternoster and three of the four transformers at Paternoster.

4.2.4 Finsbury Market B 33kV Feeder Reconfiguration

Upon completion of the Osborn Street project (project 2622; New Cross RDP), capacity headroom will be available at Finsbury Market B. A separate scheme (project 6331; detailed above) proposes the re-commissioning of 3x33kV circuits to reconfigure Paternoster substation to be supplied from Finsbury Market B.

This scheme is designed to further increase the utilisation of the 3x45MVA Finsbury Market B transformers by transferring Beech Street A substation to this site and by installing two 33kV interconnectors, with a total capacity of 45MVA, between Finsbury Market B and C to facilitate uprating of the 'green' and 'red' 33kV feeder groups to 90MVA.

The scope of works consists in re-equipping and refurbishing 4x33kV feeder bays to accommodate permanent transfers of Beech Street circuits and the new interconnectors.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

4.3 Costs and Phasing

Table 14: Proposed Interventions (NAMP Table J Less Ind. – 19th February 2014)

Cat.	Reference	Description	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A	1.26.01.6135	Finsbury Market B Install 33kV Auto Close Scheme	0	9,057	122,265	3,474	0	0	0	0	0	0
A	1.51.01.7855	Finsbury Market B 33kV - Replace Grid Transformers (GT1B, GT2B, GT3B)	0	0	0	0	76,656	2,771,861	1,385,927	0	0	0
A	1.51.01.7858	City Rd C 11kV - Replace Grid Transformer (GT3)	0	0	78,060	1,524,695	0	0	0	0	0	0
A	1.51.01.7860	Finsbury Market A 11kV - Replace Grid Transformer (GT2A)	0	0	78,060	1,524,695	0	0	0	0	0	0
A	1.51.03.7870	Paternoster - Replace Primary Transformer (T4)	0	0	82,565	492,809	0	0	0	0	0	0
A	1.51.11.7852	Finsbury Market A 11kV - Refurbish Grid Transformers (GT1A, GT3A)	0	0	164,621	125,379	0	0	0	0	0	0
A	1.51.11.7853	City Rd B 11kV - Refurbish Grid Transformers (GT1, GT2)	0	0	0	0	0	0	0	0	163,009	214,028
R	1.33.03.6158	Ludgate Circus: Establish 11kV Site	0	0	0	0	0	0	0	0	185,100	1,506,108
R	1.34.02.8435	11kV Load Transfers to Calshot St MSS	0	0	0	0	962,951	577,770	0	0	0	0
R	1.35.02.6331	Paternoster 33/11kV - Reconfiguration to Finsbury Market B (33kV circuits)	0	0	0	0	0	175,637	41,199	0	0	0
R	1.36.03.6156	Finsbury Market B 33kV Feeder Reconfiguration	0	0	0	184,692	821,422	132,485	0	0	0	0

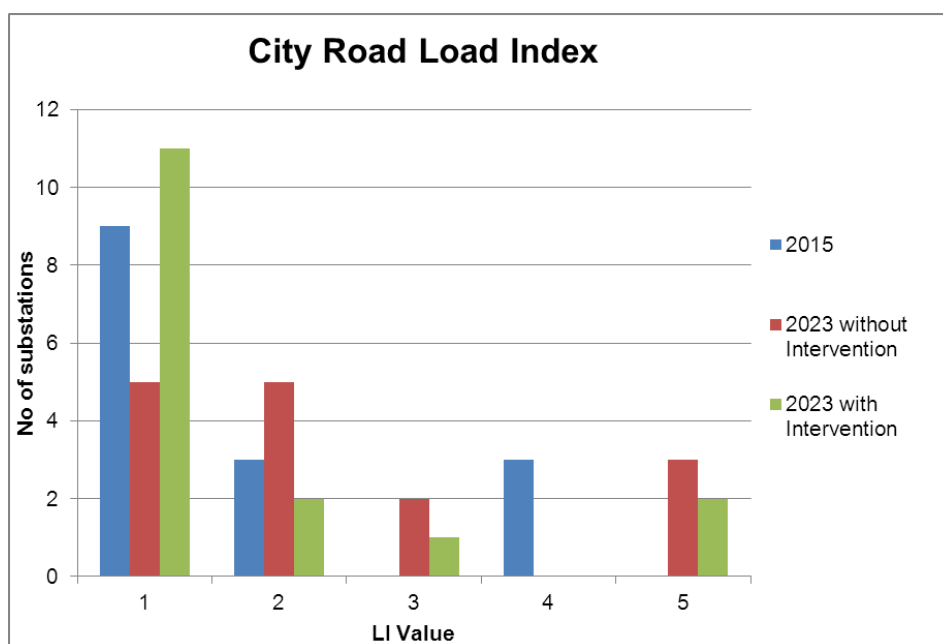
4.4 HI / LI Improvement

Table 15: LI Improvement

Substation	Voltage kV	2023 Load Index	
		Without Investment	With Investment
Beech Street A	33/11	2	2
Beech Street B	132/11	2	1
City Road B	132/11	3	1
City Road C	132/11	5	1
Devonshire Square	132/11	2	1
Finsbury Market A	132/11	3	3
Finsbury Market B 33kV	132/33	5	5
Finsbury Market C 33kV	132/33	1	1
Finsbury Market D	33/11	1	1
Finsbury Market E	132/11	1	1
Osborn Street	33/11	5	N/A
Paternoster	33/11	1	5
Tooley St via Bankside	132/11	2	2
Bankside C Total	132/11	2	1
Bankside D	132/20	1	1
Limeburner Lane	132/11	N/A	1
Calshot Street	132/11	N/A	1

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.



Health indices for all network equipment covered in this RDP with investments are listed in red font in Tables 16 to 21 below. The equipment groups covered include HV circuit breakers (6.6kV and 11kV), EHV circuit breakers (33kV), 66kV&132kV circuit breakers, primary transformers (33/11/6.6kV), grid transformers (132/33/11kV) and fluid filled cables (33kV).

Table 16: HV Circuit Breakers – HI Improvement with Intervention

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH ST A	1	7	5				1	12		
BEECH ST B	19	37					56			
CITY RD B 11KV	8	48					54	2		
CITY RD C 11KV	21						21			
DEVONSHIRE SQ		54					24	30		
FINSBURY MKT A 11KV		5	23				1	6	21	
FINSBURY MKT D 11KV		14					14			
FINSBURY MKT E 11KV	63	3					66			
OSBORN ST		27								
PATERNOSTER		21	6					27		
SEACOAL LANE 11KV	7	9	22							
PLUMTREE COURT 11kV						31				
LIMEBURNER LANE 11KV						54	14			
CALSHOT ST 11KV						30				

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Table 17: EHV Circuit Breakers - HI Improvement with Intervention

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
FINSBURY MARKET B 33KV	1	4	10				5	14		
FINSBURY MARKET C 33KV	1	12					7	6		
HOXTON 33KV	2					2				
MANSELL ST (LUL) 22KV		4					4			
LIMEBURNER LANE 11KV						3				
CALSHOT ST 11KV						2				

Table 18: 66 and 132kV Circuit Breakers - HI Improvement with Intervention

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
CITY ROAD 132KV	1	19					15	5		
SHOREDITCH 66KV		1		5						

Table 19: Primary Transformers - HI Improvement with Intervention

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH ST A		2						2		
FINSBURY MKT A 11KV		1						1		
FINSBURY MKT D 11KV		3					1	2		
OSBORN ST		4								
PATERNOSTER		1				1		3		

Table 20: Grid Transformers - HI Improvement with Intervention

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BEECH STREET B		3					3			
CANAL STREET	2					2				
CITY ROAD B 11KV		1	1				2			
CITY ROAD C 11KV	1			1		1	1			
DEVONSHIRE SQ		3							1	2
FINSBURY MARKET B 33KV		1	1	1		3				
FINSBURY MARKET C 33KV			1	2				1		2
FINSBURY MKT A 11KV			2	1		1	2			
FINSBURY MKT E 11KV	1	2					3			
HOXTON 33KV	1					1				
MANSELL ST (LUL) 22KV		2					2			
LIMEBURNER LANE 11KV						3				

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

CALSHOT ST 11KV

2

Table 21: Fluid Filled Cables - HI Improvement with Intervention

Section (Route)	Cable Section	Voltage kV	2015 HI	2023 HI
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-1-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-2-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-3-A	33	2	3
BEECH ST A-PATERNOSTER	CABLE SECTION: 04070476-4-A	33	2	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-1-A	33	3	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-2-A	33	2	3
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-3-A	33	2	2
FINSBURY MARKET B 33KV-WHISTON RD	CABLE SECTION: 34290495-4-A	33	2	2
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-1-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-2-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-3-A	33	2	3
FINSBURY MARKET C 33KV-BEECH ST A	CABLE SECTION: 34320407-4-A	33	2	3

Notes: 1) Limeburner Lane and Calshot Street substations as well as Plumtree Court switching station will be commissioned within ED1; 2) Seacoal Lane will be replaced by Limeburner Lane and Osborn Street will be replanted at 132kV and fed from New Cross GSP; 3) Shoreditch 66kV switching station will be decommissioned within ED1 as part of the works to replant Hearn Street at 132kV (scheme 3657; details in New Cross RDP); 4) Paternoster will return to its initial state by the end of ED1 (4x33/11kV transformers) and will pick up the demand currently covered by 3x11kV circuits from Bankside C.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

5 Rejected Strategies

The following options were considered for the aforementioned reinforcement schemes:

5.1 Calshot Street: Establish 2x66MVA 132/11kV Substation

Rejected Option 1: Build a new 132/11kV main substation (2x33MVA transformers).

This option is rejected as it does not solve the loading issues of the surrounding substations. The proposed substation would only have a summer firm capacity of 42MVA and could only accept one 11kW group (Back Hill 11kW North Group). Space on site is very restricted, so there would be no opportunity to install a future third transformer.

Rejected Option 2: Reinforce Back Hill A 11kV and City Road B 11kV.

Both sites have insufficient space to accommodate the necessary additional equipment. Furthermore, it has been identified that even if the transformer capacity is increased, there would still be problems accessing the new capacity (difficulty to get new cables out of the substations).

5.2 Plumtree Court - 11kV Switchboard Extension

Rejected Option: Extend customer switchboard by 21 additional panels.

This option includes extending the proposed customer switchboard by 21 panels, allowing for City Road North group to also be transferred to the new switchboard. This option was rejected due to space constraints at the customer site.

5.3 Ludgate Circus: Establish 11kV Site

Rejected Option: Install reinforcement 11kV cables in the City Road-Bankside/Limeburner Lane tunnel system.

This option involves installing additional 11kV cables in the City Road-Bankside/Limeburner Lane tunnel system utilising the existing feeder panels for use in reinforcing interconnected feeder groups in the area around Ludgate Circus. Installation of additional 11kV cables in the tunnel is not feasible due to thermal constraints. All the cables in the tunnel will assume lower ratings due to overheating as they will operate in a higher ambient temperature environment. This will result in no benefit being derived from installation of the additional 11kV cables and it will create bottlenecks for the existing cables. Furthermore, due to a limited number of spare feeder panels and space constraints to extend switchboards at Bankside C, South Bank, Seacoal Lane 11kV (Limeburner Lane), Paternoster and City Road substations, 11kV feeders on their own will not provide adequate capacity for the required reinforcement. This option has therefore been rejected on technical and feasibility grounds.

5.4 Paternoster 33/11kV - Reconfiguration to Finsbury Market B (33kV Circuits)

Rejected Option: Create additional capacity for London by upgrading Paternoster to a 132/11kV, 3x33.3MVA substation fed from Limeburner Lane.

This option is for the removal of the existing four 33/11kV transformers and the installation of 3x132/11kV 33.3MVA transformers. The transformers will be fed from Limeburner Lane by three new 132kV circuits run through the tunnel connecting these sites. The length of the new circuits will be approximately 300m each. This option is rejected on the basis of cost, complexity and technical grounds (height restriction within the transformers chambers).

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

6 References

References	Description
Reference 1	Planning Load Estimates LPN Area 2011 – 2023 (February 2013 – Element Energy Version)
Reference 2	Primary Distribution Systems Standard Running Arrangements 2012 Overview Diagrams
Reference 3	NAMP LPN Table J Less Ind – 19 th February 2014
Reference 4	Asset Condition Reports June 2013
Reference 5	Islington Council – Core Strategy / City Road Masterplan / City Road Basin Area

6.1 Appendices

Appendix	Description
Appendix A	Geographical Layout
Appendix B	Single Line Diagrams – Existing Network
Appendix C	Single Line Diagrams – Recommended Strategy
Appendix D	Schematic Diagram – Existing Tunnel Network

6.2 Document History

Version	Date of Issue	Author	Details
1.0	21 June 2013	Barry Walker	For Comment
2.0	07 March 2014	Panagiotis Xenos	Reviewed for ED1 Plan Resubmission
2.1	21 March 2014	Panagiotis Xenos	Final Amendments for ED1 Plan Resubmission

7 Document Sign Off

Sign-off of this Mandate certifies that the Sponsor has ratified the above and approval is sought to proceed to the development of the necessary PG&C Gate B documentation.

Recommended by:

Name	Role	Signature	Date
Panagiotis Xenos	Infrastructure Planner		
Sophie Motte	IDP Coordinator (LPN)		
Chris Winch	Planning Manager (South)		

Approval by:

Name	Role	Signature	Date
Robert Kemp	Head of System Development		
Barry Hatton	Director of Asset Management		

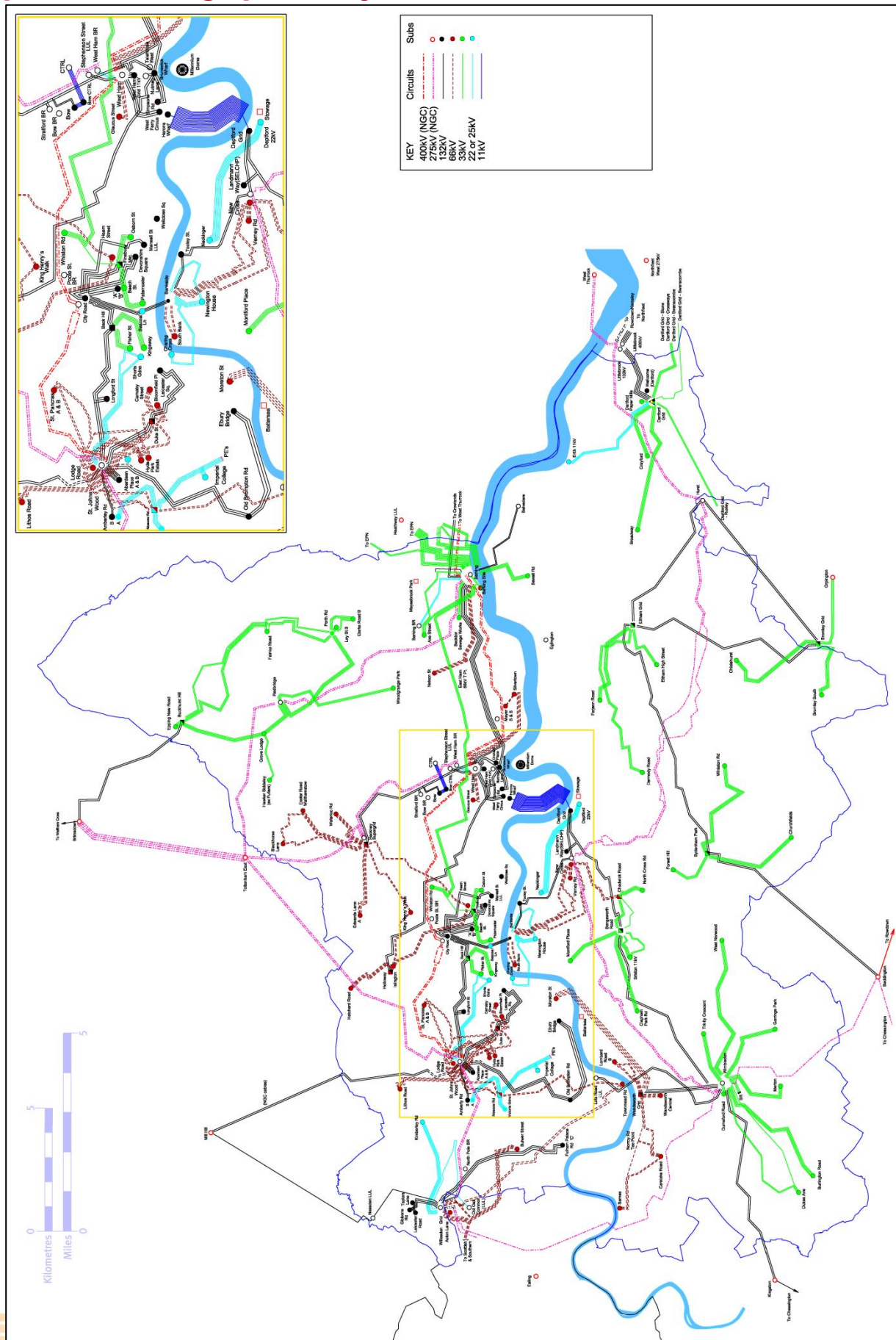
City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Appendix A: Geographical Layout



All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

City Rd 132kV

400/132 kV 6"240 MVA

SGT4 SGT1 SGT2 SGT3 SGT5 SGT6

Sect. 1 130 120 Sect. 2 230 220 330 Sect. 3

1 3 3 2 1 1 2 3 2 2 2 1 1/3

to Back Hill 132kV

132/33 kV 60 MVA

Hoxton 33kV BSP F8003 EML 0

Hoxton TSS F8003 33kV

132/22 kV 2"85 MVA

1 2

1A 1B 2A 2B 3A 3B

PC 1 4 PC 2 3

Mansell St 22kV EML 39

132/11/11 kV 3"60/30/30 MVA

1 2 3

1A 1B 2A 2B 3A 3B

TT TT TT

14.5 MVAR capacitor banks

Beech Street 'B' 11 kV EML 82

to Bankside F 132kV

to Finsbury Market 132kV

Warning: Loss of City Road 132kV - Finsbury Market 1, 2 or 3 circuits during peak summer loads may result in high loading seen on the remaining circuits.

132/11/11 kV 2"60/30/30 MVA

1 2

1A 1B 2A 2B

PC TT

3/4.5 MVAR capacitor banks.

City Rd B 11 kV EML 123 **

(** is the addition of T1 + T2 + T3)

City Rd C 11 kV EML 54 *

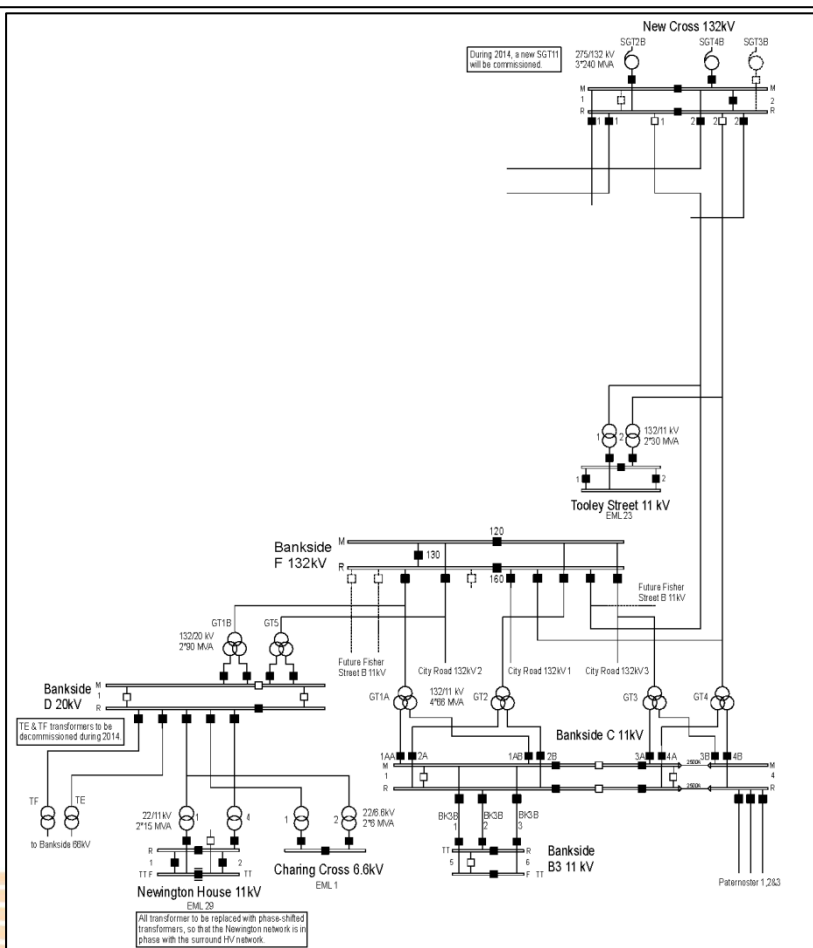
(* is T4 load only)

Seacoal Lane 11 kV EML 55

City Road T4 to supply Seacoal Lane 11kV busbars via 7 feeder group.

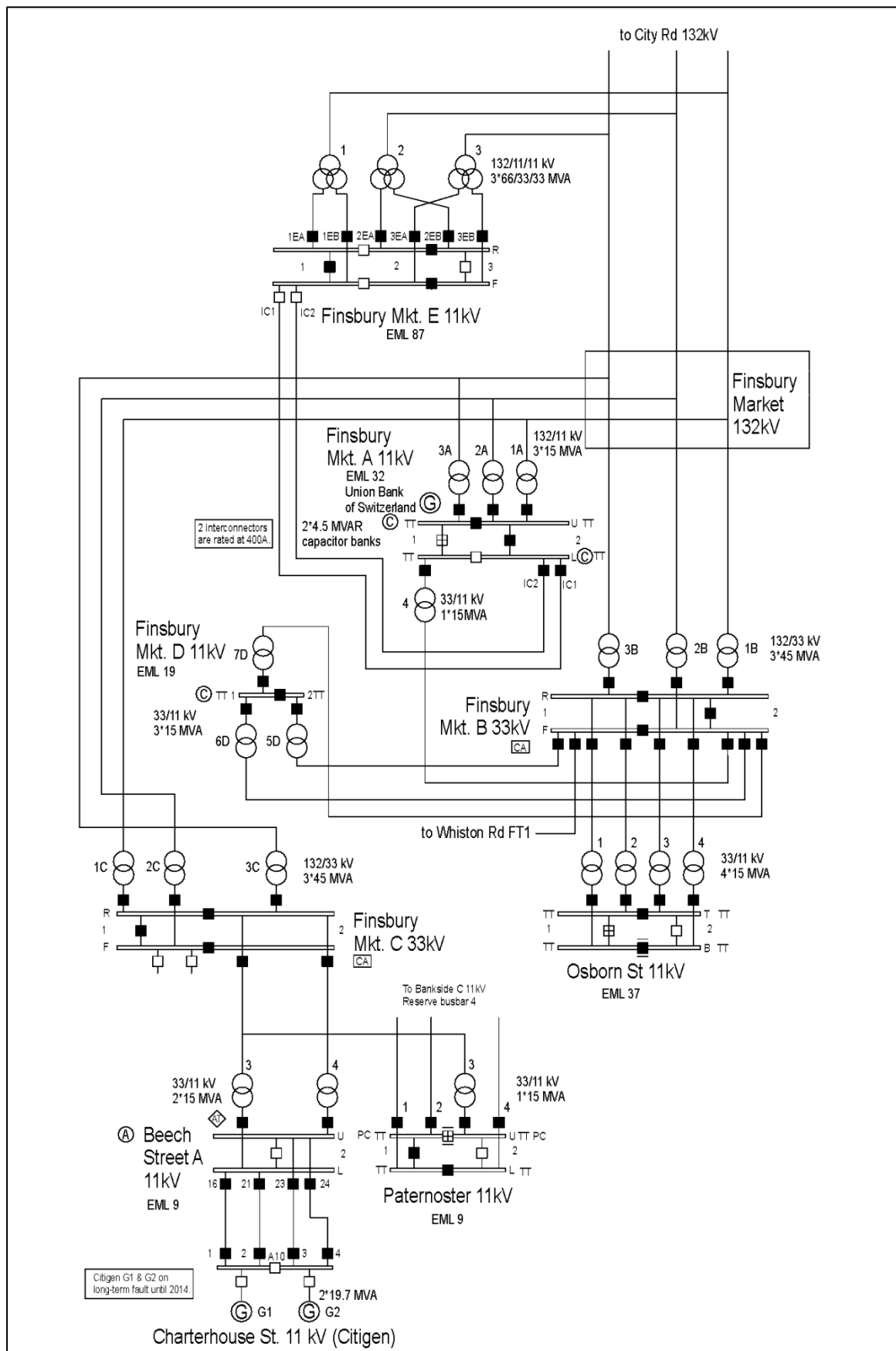
All 7 feeders are rated at 630A.

Section 1 & 3 busbars are rated at 1200A. Section 2 busbars are rated at 2000A.



City Road City of London (excluding 33kV)

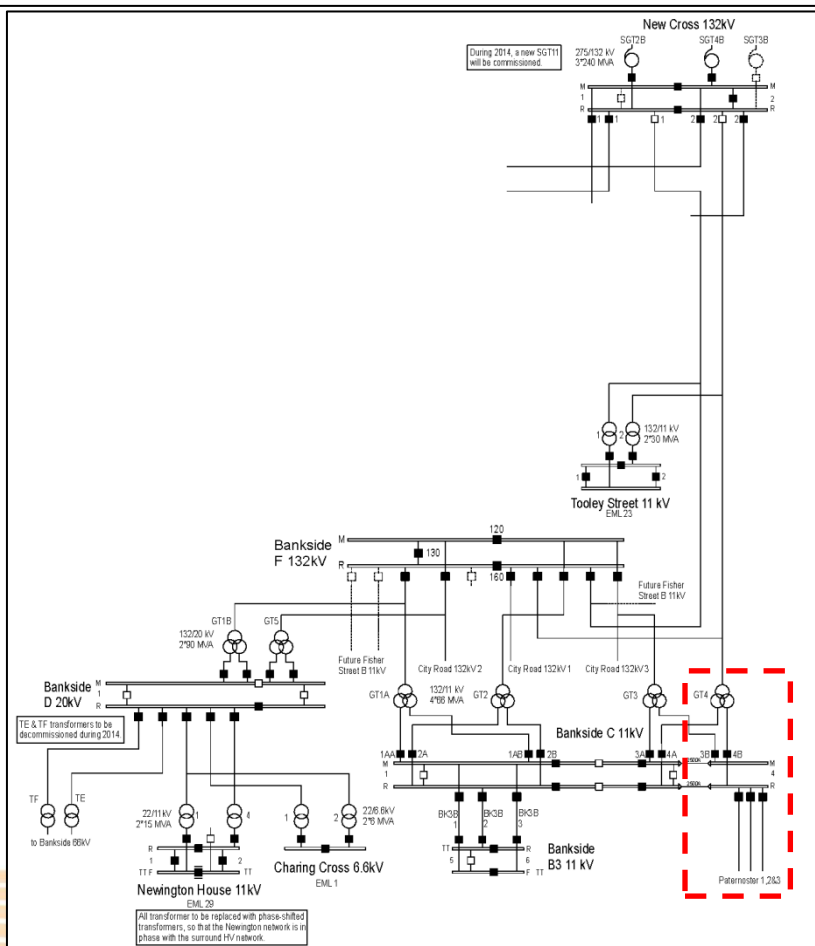
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.



City Road City of London (excluding 33kV)

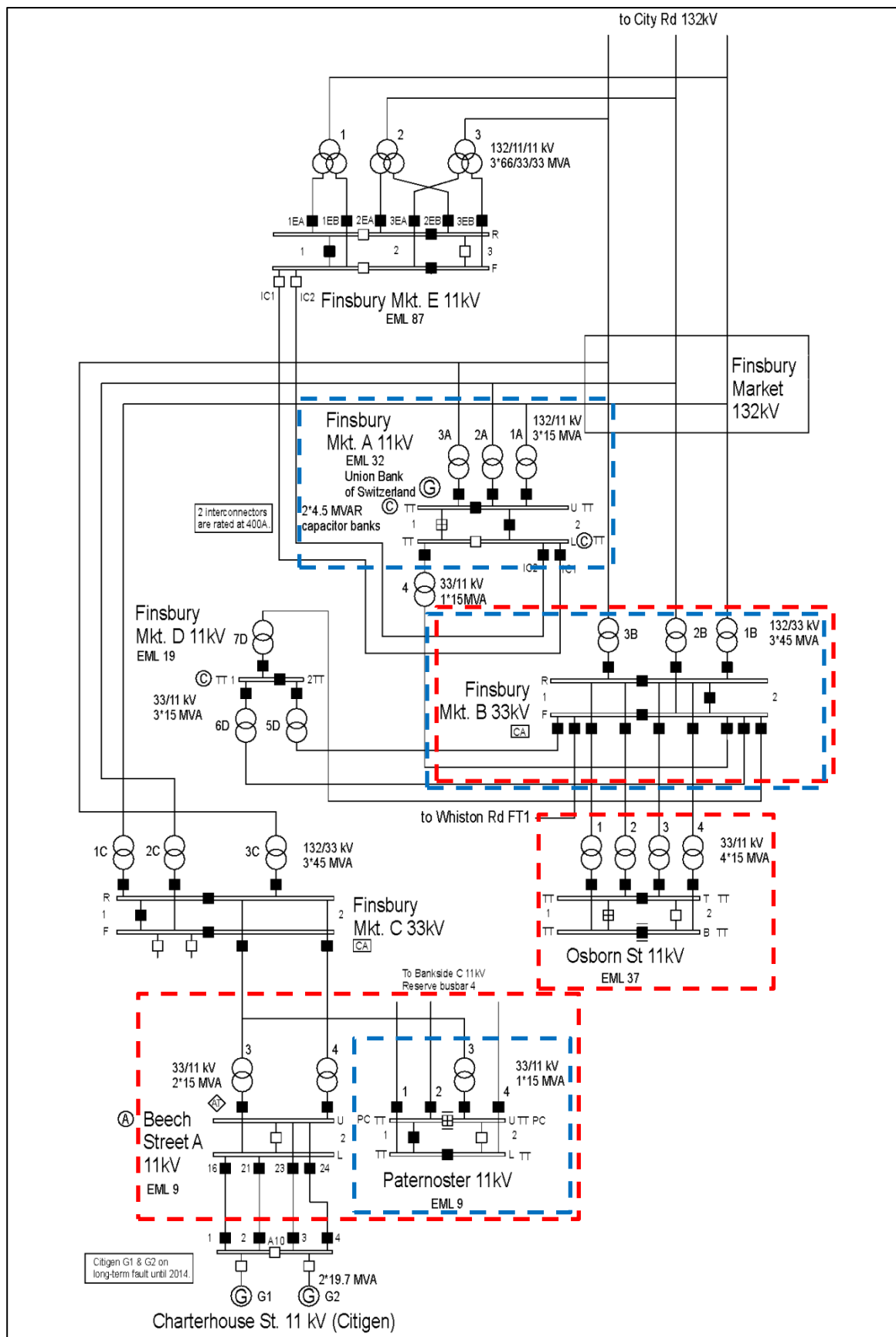
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.



City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.



City Road City of London (excluding 33kV)

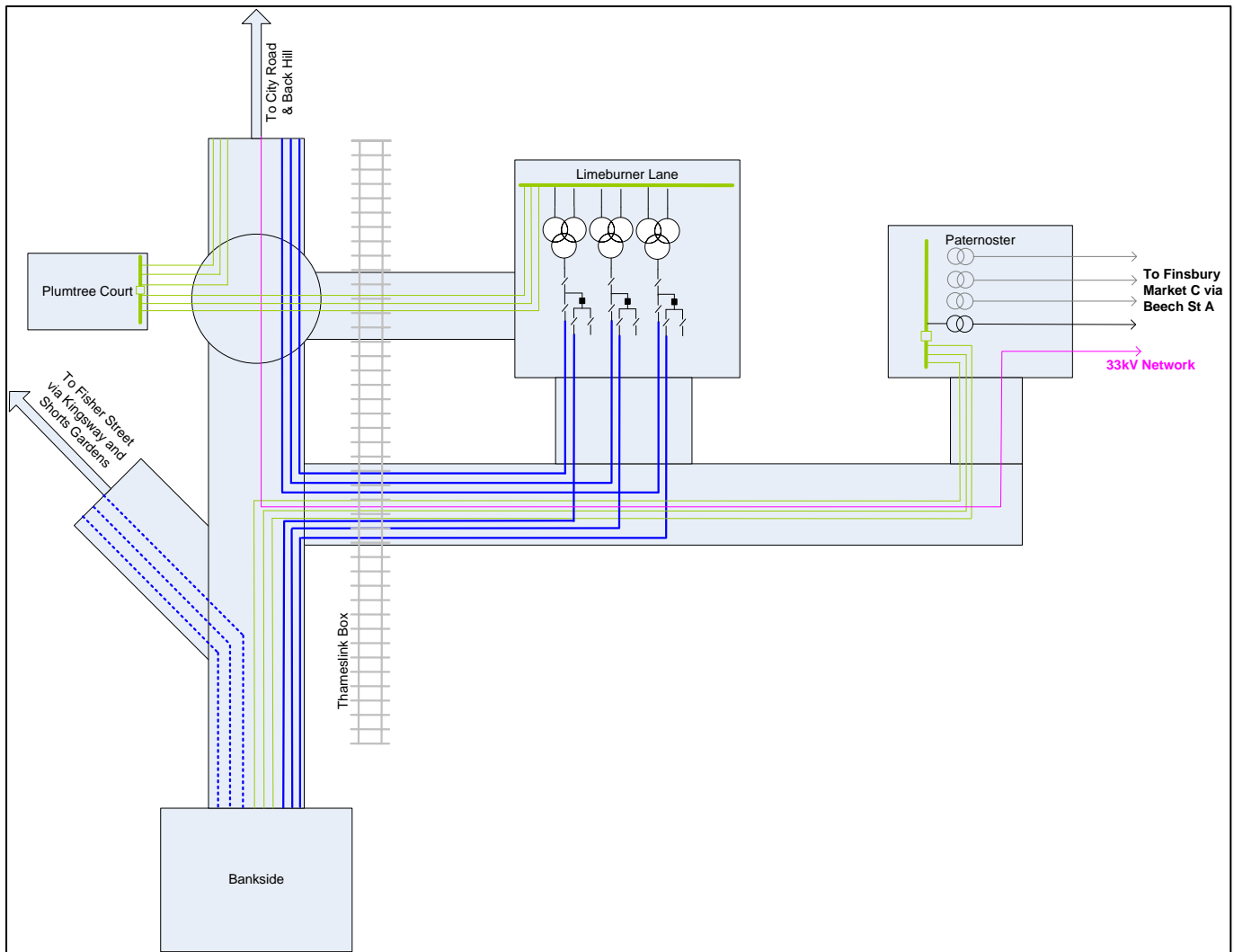
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Note: The above diagrams illustrate the proposed network changes marked in red and blue depicting reinforcement works and asset health driven works respectively. Detailed drawings can be found in the individual reinforcement scheme papers.

City Road City of London (excluding 33kV)

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Appendix D: Schematic Diagram – Existing Tunnel Network



Note: Limeburner Lane Substation (ex-Seacoal Lane) will be commissioned in 2015.