



Regional Development Plan

Elstree & Mill Hill & Willesden (EPN)

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

Document History

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1.2	17/03/2014	Major	Paul Ramsbotham	1.2, Appendix D	Expenditure aligned to the 19th February 2014 NAMP version J less indirect costs.
1.2	17/03/2014	Major	Paul Ramsbotham	1,2,3,4,5	RDP narrative updated to reflect latest position
1.2	17/03/2014	Major	Paul Ramsbotham	1.2, Appendix E, Appendix F	LI and HI output measures updated in line with current NAMP plan and RIG tables
1.2	17/03/2014	Minor	Paul Ramsbotham	2.2	Network changes in progress updated to reflect interventions to date
1.2	17/03/2014	Major	Paul Ramsbotham	4	Recommended strategy reflects latest position
1.2	17/03/2014	Major	Paul Ramsbotham	Appendix G	Generation activity reflects latest position
1.2	19/03/2014	Minor	Steve Mould	All sections	All sections checked for consistent section numbering, content etc.
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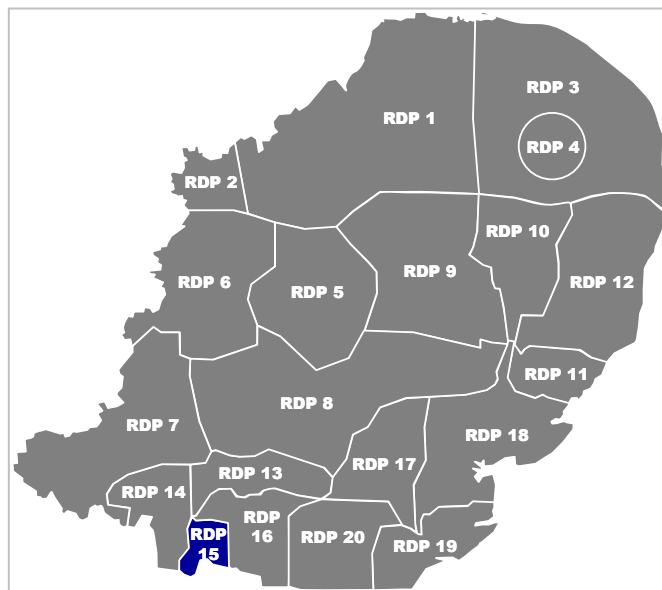
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1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) EPN HV and EHV network of the north London borough of Barnet, supplied from National Grid Supply Points (GSPs) at Elstree, Mill Hill and Willesden (LPN).

Barnet is the fourth largest London borough by area (86.7 sq km) and home to a growing and diverse population of circa 350,000 and expected to rise to circa 384,000 over the next 20 years. About 38% of the borough is undeveloped, 28% is designated green belt and 8% is metropolitan open land (which includes around 200 parks, allotments, playing fields and agricultural land).

With significant growth in Barnet's population and economy expected over the next twenty years work is well under way by Barnet Council on planning of the opportunity areas (Brent Cross - Cricklewood and Colindale) and area of intensification (Mill Hill East) identified in the London Plan. The development/regeneration of these areas alone is expected to deliver over 16,000 new homes by 2026. Many of the people who work in Barnet also live in the borough. Nearly 75% of the 112,000 jobs in the borough are held by Barnet residents, one of the highest figures in London. The majority of working residents are employed in the public sector or financial services.



1.1 Summary of issues addressed

This RDP is primarily focussed on the delivery of 33/11kV capacity to support the increased load growth (both commercial and residential) across the RDP area. In addition there are numerous projects focussed on the Health Index of switchgear operating at 11, 33 and 132kV. With the exception of proposed switchgear removal at Mill Hill 132kV, the asset replacement schemes identified in this RDP are not reconfiguring the existing network, but addressing the issue of ensuring continued security of supply and maintaining a safe a reliable electricity distribution network.

1.2 Recommended strategy

From a load related expenditure perspective the strategy for this RDP area is primarily focussed on the provision of 33/11kV Primary and 132/11kV Grid capacity to cater for the increased load from both commercial and residential developments across the RDP area.

The strategy for this area also includes schemes to increase the 11kV interconnection capacity between Primary substations, two notable schemes are:

- Brockenhurst – Mill Hill
- Hendon Way – Golders Green

At 132kV the removal of the Mill Hill busbar and connection of 132kV double circuits to Hendon and Finchley Grid directly to the supergrid transformers (SGTs) will avoid issues with the ageing assets (AEI OW410 bulk oil breakers dating from the mid 1960s) currently owned by National Grid. When the London Underground Limited (LUL) Neasden connection is removed from the Mill Hill 132kV busbar UKPN then becomes the sole user of the assets.

The 132kV indoor double busbar at Hendon was commissioned in 2009 and will provide the new connections for LUL Neasden and operational flexibility to maintain compliance with Security of Supply Standard ERP2/6.

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Investment Profile

Figure 1 provides the projected expenditure profile for reinforcement and asset replacement projects (LRE and NLRE) in this RDP for both DCPR5 and ED1. This information is taken from the NAMP version 19-02-2014.

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIO-ED1 Total
RDP15	LRE	£3.7m	£0.1m	£1.0m	£2.0m	£0.7m	£0.0m	£0.3m	£0.9m	£0.7m	£5.8m
	NLRE	£5.5m	£1.3m	£1.0m	£1.7m	£2.9m	£1.2m	£0.7m	£0.4m	£0.9m	£10.3m
	TOTAL	£9.2m	£1.4m	£2.0m	£3.7m	£3.7m	£1.3m	£1.0m	£1.4m	£1.6m	£16.1m

Table 1. LRE and NLRE expenditure profile

Output Measures

The figure below provides the expected Load Indices (LI) for all substations covered in this RDP at the end of the ED1 period (2022/23). Substations with a projected load index of LI4 and LI5 will be specifically targeted for improvement and are detailed in this document, with the resulting improvement also shown in the figure below.

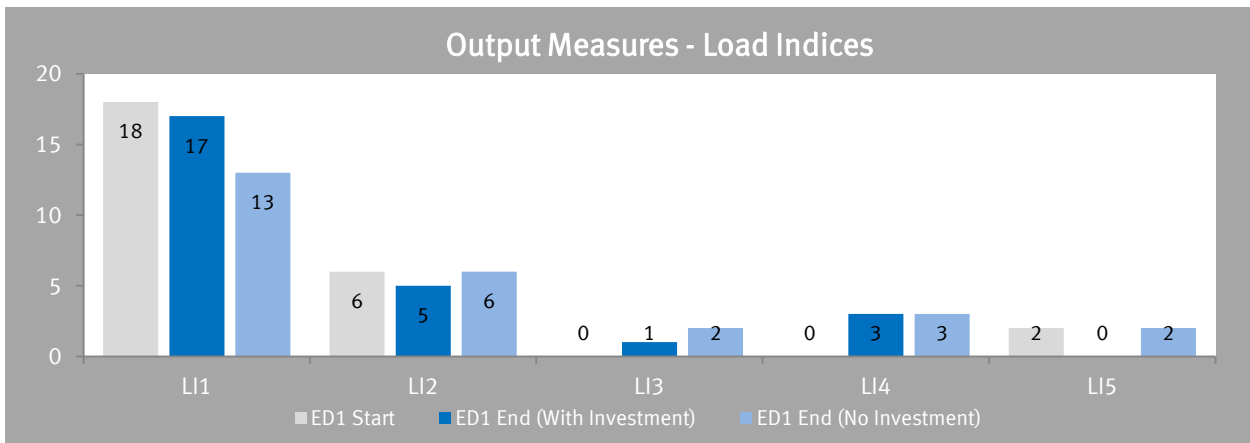
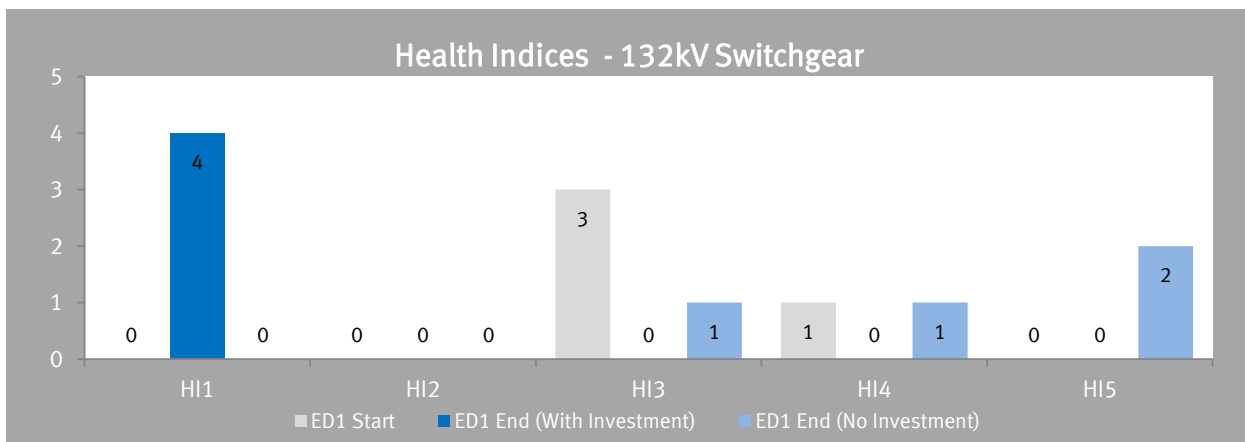


Figure 1. 2022/23 Load Indices with and without interventions

The figure below provides the projected health index of various assets covered in this RDP at the beginning and end of ED1, with and without interventions as defined in the NAMP under asset replacement.



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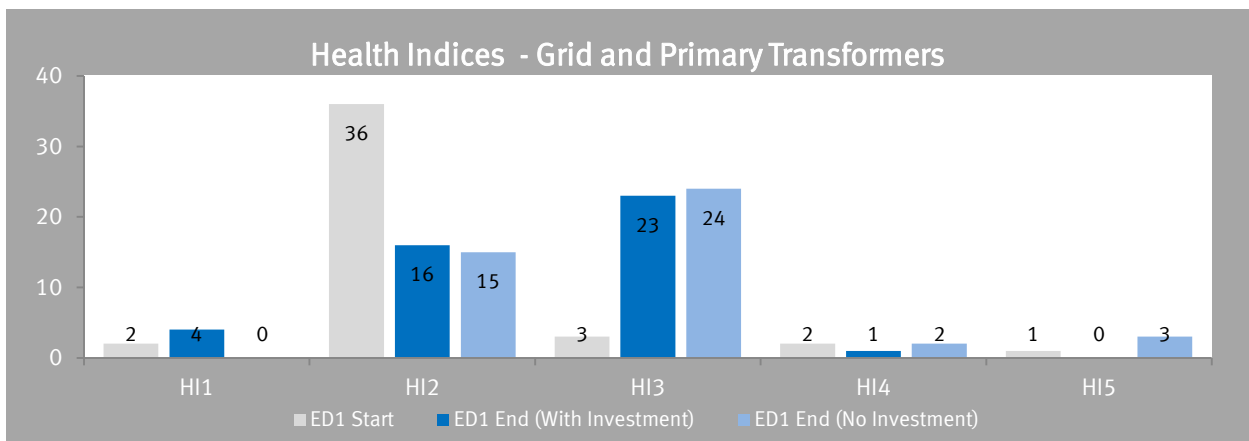
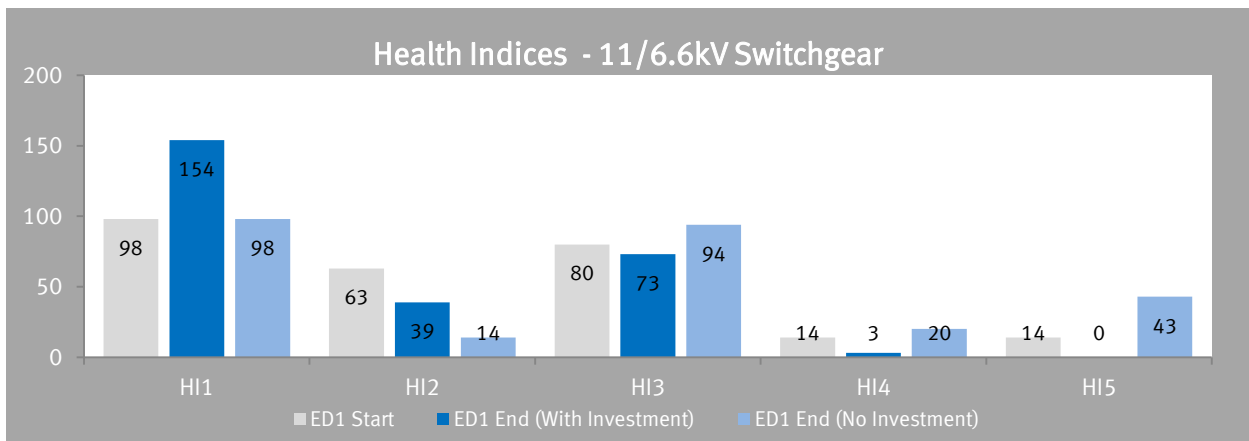
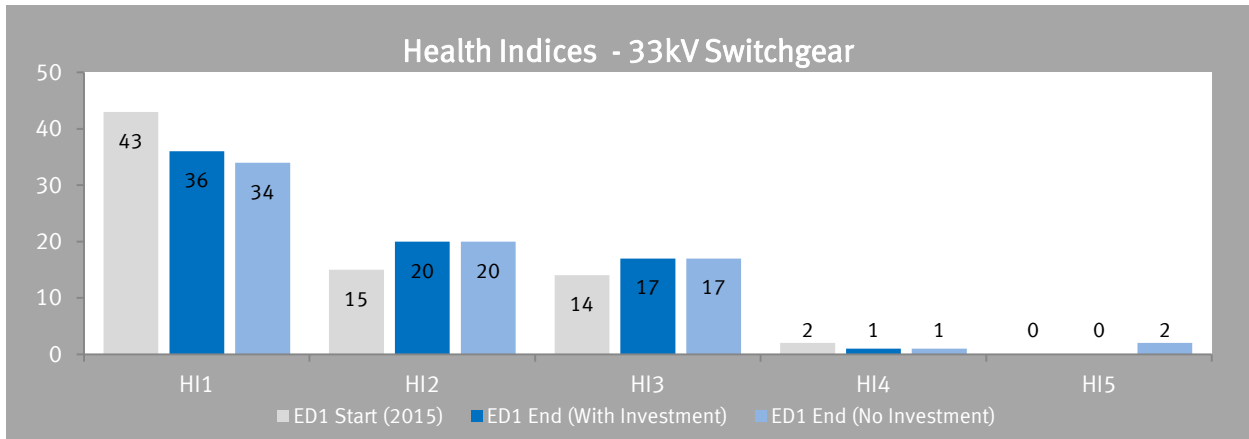


Figure 2. Health Indices by asset category

Scenarios Considered

The reinforcement strategy for Elstree, Mill Hill and Willesden is defined by individual substation reinforcement to provide capacity at 11kV and the growth forecast does not warrant reinforcement at the 33kV level or above. As such, alternative scenarios were considered for the individual substation reinforcements such as:

- Transfer load to Frogmore and St Pauls
- Transfer load to Hartspring

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RDP Dependencies and Interactions

This RDP assumes the work to replace the 132kV bars at Elstree 132 is completed and the LUL Neasden supply is moved from Mill Hill/Willesden to Hendon 132kV.

Any work at Mill Hill 132kV cannot commence until Elstree 132 has been completed.

For an overview of the wider area the following RDPs should also be considered:

- RDP14 Elstree – Watford South Group
- Willesden RDP (LPN)

2 Network configuration

2.1 Existing Network

The Hendon and Finchley areas of north London are supplied from National Grid exit points located at Mill Hill and Elstree. A Geographic diagram can be found in Appendix A.

The Mill Hill exit point is equipped with 2 x 275/132kV, 240MVA transformers and 2 x 275/132kV 180MVA transformers connected to a 132kV outdoor switchboard, which contains AEI OW410 bulk oil circuit breakers dating from the 1960s. The National Grid supergrid transformers are connected in banked pairs to a dual circuit 275kV tower line, 1 x 240MVA and 1 x 180MVA transformer are connected to each circuit.

The Mill Hill 132kV busbar connects to Finchley Grid (132/33kV) and Hendon 132 bus bar via 4 x 132kV oil filled underground cable circuits (2 circuits to Finchley and 2 circuits to Hendon), UKPN owns the circuit bays at Mill Hill 132kV. A traction transformer location at BR Grahame Park is also teed off the Hendon 132kV No.1 circuit.

Finchley Grid is equipped with 2 x 132/33kV, 90MVA Hackbridge transformers commissioned in the early 1960s and connected to a 3 section 33kV indoor switchboard equipped with Ferguson Palin oil breakers. Finchley Grid supports Primary substations (33/11kV) located at East Finchley, North Finchley, East Barnet, Bellevue and Church End.

Also connected to the Mill Hill 132kV bar is 1 x 132kV cable to the 22kV London Underground substation at Neasden, a second supply is currently taken from Willesden (LPN). London Underground Limited (LUL) has recently accepted a quotation to remove the existing supplies from both Mill Hill and Willesden, which are to be replaced with a new 132kV supply from Hendon (2 x 132kV dedicated circuits). When the LUL Neasden supply is removed from the Mill Hill busbars it is likely that UKPN will be required to adopt the assets as EPN will be the only DNO supplied from the bars.

The Hendon 132kV indoor double bus bar is equipped with Siemens GIS 2500A switchgear, was commissioned in 2009 and is connected via 2 x 132kV circuits from Mill Hill and 1 x 132kV circuit from Elstree 132 (currently SGT8), which all run in parallel. The 132kV bars currently support both Hendon Grid (132/33kV) and Colindale Grid (132/11kV), and will also provide the new LUL Neasden connection as previously described.

Hendon Grid is equipped with 2 x 90MVA 132/33kV English Electric transformers connected to a 3 section 33kV switchboard equipped with ABB gas insulated switchgear and commissioned in 2013. It is anticipated that Hendon Grid will be reinforced with an additional 132/33kV, 90MVA transformer in the future. Hendon Grid supports Primary substations (33/11kV) located at Hendon Way, Wembley Park, Golders Green, Kingsbury, Manns Rd, Brockenhurst and Mill Hill.

Colindale Grid is equipped with 2 x 60MVA (dual wound) 132/11kV Fuller Electric transformers commissioned in 1967. The 11kV double busbar is equipped with a mixture of original Associated Electrical Industries (AEI) oil and retrofit SPE vacuum circuit breakers. The bus section circuit breakers run open to control fault levels with both transformers in service.

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2.2 Network changes in progress

Elstree GSP 132kV Exit Point - replace 132kV switchgear

The outdoor OB14 circuit breakers at Elstree are at the end of their useful life. Access restrictions are in place due to the known defects. The concrete support structures, aerials, VTs and other associated plant are also in very poor condition. National Grid, who owns the 132kV bus-bar, plans to replace their 132kV switchgear at this site. The UK Power Networks equipment is of the same type and age. Recent operational restrictions affect this switchgear and it is proposed to replace it at the same time. National Grid reviewed the possibility of refurbishing the existing AIS switchboard and concluded that it was not possible due to operational and HSE considerations. A new 3 section, double busbar GIS switchboard is in the process of construction. National Grid are rationalising the 132kV substation, it is planned that SGT 8 and SGT9 (both 240MVA) together with the Stanmore 132kV circuits and Hendon 132kV circuit (NG owned and installed in their cable tunnel) will be connected to the centre section of the new switchboard. The existing cable tails to Rye House and to Watford South are not matched to the rating of the 400mm OHL, it is therefore proposed to replace these cables.

Golders Green 33/11kV and Hendon Way 33/11kV Primary Substations

At Golders Green a new 11kV 3 section 2000A HSS Eclipse switchboard was commissioned in January 2013.

Approval was achieved in December 2012 to replace the existing Golders Green 15MVA T2 33/11kV transformer with a 12/24MVA unit as part of DPCR5 reinforcement plan, replace the Hendon Way 11kV switchboard which is equipped with original oil and retrofit South Wales Switchgear withdrawable circuit breakers and install 11kV interconnection between Golders Green and Hendon Way. It is proposed that these sites will run as an interconnected group at 11kV and hence increase the n-1 firm capacity at both sites. The new Hendon Way switchgear was commissioned in 2013.

Note that Golders Green T1 had already been replaced with a 12/24MVA Brush transformer following a tap changer failure on the original 15MVA unit in February 2012.

Hendon 132/33kV Grid Substation - replace 33kV switchboard (2500A)

The 33kV switchgear at Hendon Grid was SWS ET outdoor cubicle type dating from 1965. As part of the asset replacement strategy the switchgear was replaced with a 3 section indoor board, which was commissioned in 2013.

Kingsbury 33/11kV Primary Substation

A new 11kV 2 section 2000A HSS Eclipse switchboard was commissioned in November 2012. The new assets replaced the Yorkshire Switchgear IVIF switchboard which was commissioned in the early 1960s and had no remote control facility.

Manns Road 33/11kV Primary Substation – Replace 11kV switchboard (2000A)

The 11kV switchboard at Manns Road Primary was replaced in 2013 with a new 11kV 2 section 2000A indoor switchboard. These works replaced the British Thompson Houston oil switchgear which was manufactured in 1958 and had no remote control facilities.

3 Summary of Issues

3.1 Development areas

The area fed from Mill Hill / Elstree 8 & 9 is covered by Barnet Council, the major areas for development include:

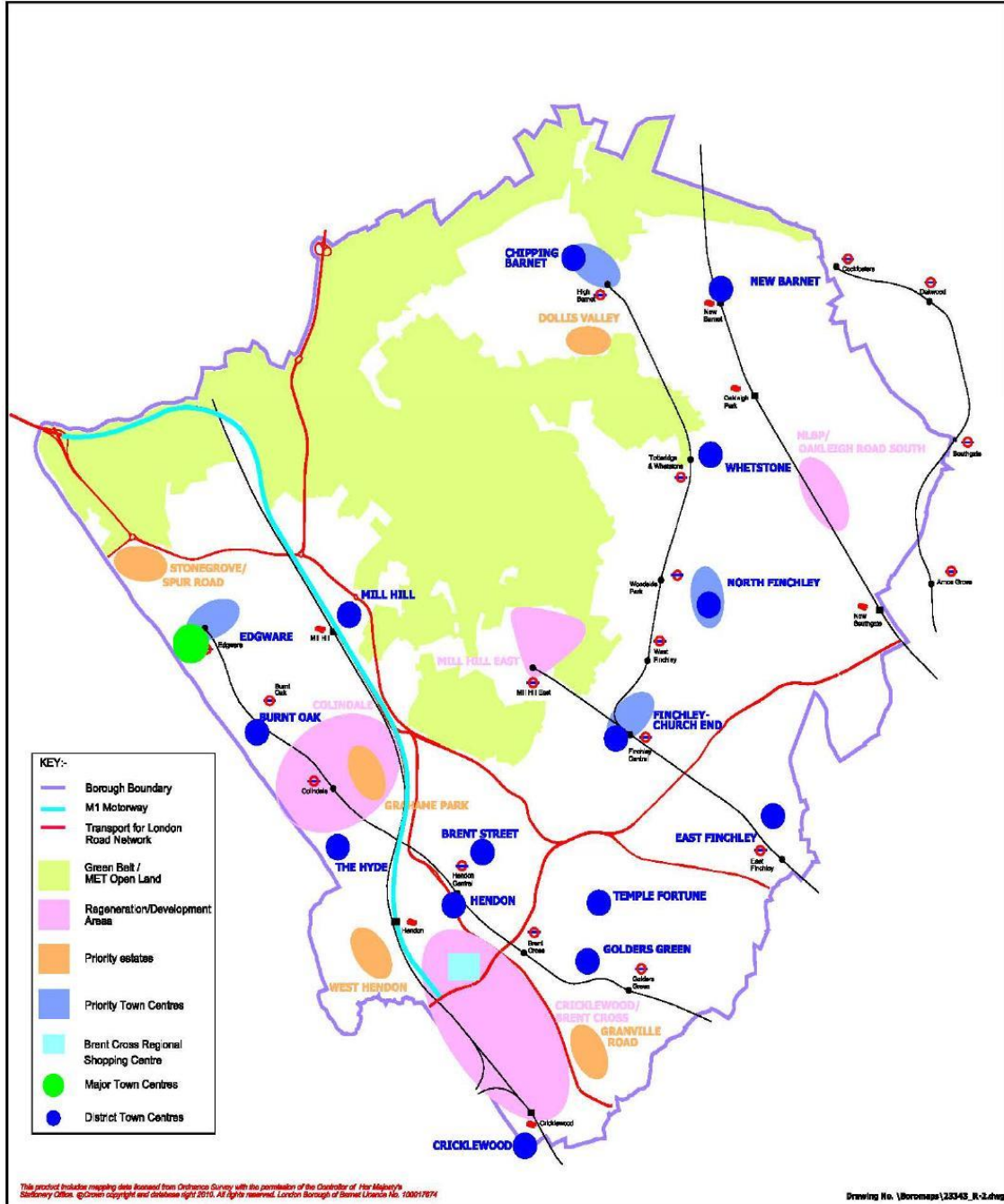
- Colindale (Colindale 11)
- Cricklewood / Brent Cross (Golders Green / Hendon Way)

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- Mill Hill East (Church End)
- North London Business Park (NLBP) / Oakleigh Road South (East Barnet)

The map below indicates the areas of proposed development / regeneration as per the Barnet Local Plan (Core Strategy) September 2012.



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In addition to the delivery from major growth areas of over 16,000 new homes it is a major priority to regenerate housing estates in Barnet at Dollis Valley, Grahame Park, Granville Road, Spur Road - Stonegrove and West Hendon. These estates will be subject to long term programmes of regeneration in order to tackle poor quality housing, social isolation and transform these areas into successful mixed tenure places. These estates (excluding Grahame Park which is counted as part of the Colindale regeneration area) will provide nearly 2,200 new homes by 2026. Further details on the regeneration of the priority estates are set out below.

- **Dollis Valley**

The Dollis Valley Estate was built in the late 1960s and early 1970s. The objective of the regeneration of the Dollis Valley Estate is to establish a new revitalised neighbourhood on the edge of Green Belt. Around 440 homes on the Estate will be demolished and replaced by 620 new homes. New homes are expected to be delivered from 2013/14 as part of a programme which will be completed by 2021.

- **Grahame Park**

The Grahame Park Estate is the largest post-war housing estate in Barnet. Regeneration proposals for Grahame Park aim to transform the estate into a 3,440-home mixed tenure neighbourhood. The Estate forms part of the Colindale Regeneration Area (Grahame Park Way Corridor of Change). Around 1,310 homes will be demolished and 460 retained providing a net increase of 1670 new homes. The regeneration is to be taken forward in two stages. Stage A is under way and comprises 962 new homes. Stage B will comprise 2,015 new homes. Stage A is expected to be completed by 2016. Stage B is expected to be delivered between 2015 and 2026.

- **Granville Road**

The Granville Road Estate was built in the 1960s and consists of three 15 storey tower blocks and a further three blocks of low rise housing. It is in need of capital investment to refurbish the tower blocks and also to improve the estate environment and integrate it with the surrounding community. Within the estate there are some surplus lands and these offer the opportunity to build some additional homes for private sale, and intermediate housing for sale, thus creating a mixed tenure community. The regeneration of the estate will be in two phases. The first phase the refurbishment of the tower blocks is under way and the second phase will be the building of new homes. It is expected that in the range of 130 to 140 new homes will be built. New homes are expected to be delivered by 2016.

- **Stonegrove and Spur Road**

Stonegrove and Spur Road are two post war interconnected housing estates in Edgware which are being redeveloped as one. Regeneration will create a new neighbourhood linked to its surroundings on the edge of London's Green Belt. Nearly 1,000 new homes will be provided to replace 600 existing ones, a net increase of 400. This programme is well under way and is expected to be completed before 2021.

- **West Hendon**

Located between the A5 and the Welsh Harp Reservoir the West Hendon Estate is another product of the 1960s. The existing 680 homes will be replaced by a new mixed tenure neighbourhood of up to 2,200 new homes, a net increase of 1,500 homes. In addition approximately 10,000m² of non-residential floorspace will be built to help create a focal point around a new town square. This programme is under way. It is estimated that the scheme will be completed before 2026. The redevelopment of West Hendon is being taken forward in parallel, but independently of the regeneration of Brent Cross – Cricklewood.

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3.2 Asset Replacement

A list of plant recommended for replacement has been included in the ED1 NAMP plan. Dates given are provisional and will change for operational or other reasons such as reinforcement. Costs are generic for the specific plant only and do not take account of any associated equipment which may need replacing at the same time (e.g. structures/bus/line isolators on outdoor CBs).

Wealdstone 33/11kV Primary Substation - Replace 33kV Switchgear

The condition assessment of the 1963 YSE HIVE18 indoor oil insulated switchgear installed at Wealdstone 33/11kV Primary 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 its replacement.

Wealdstone 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1966/67 AEI JB721/JB821 indoor oil insulated switchgear installed at Wealdstone 33/11kV Primary 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 its replacement.

Arnos Grove 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1958 MVI V1RH1S installed at Arnos Grove 33/11kV Primary 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 its replacement. Completion of the project will see 15 circuit breakers replaced with 15 new circuit breakers, including other CB types.

Stonegrove 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1963 AEI JB921 indoor oil insulated switchgear installed at Stonegrove 33/11kV Primary 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 its replacement.

Brockenhurst 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1963 AEI JB921 indoor oil insulated switchgear (No R/C) installed at Brockenhurst 33/11kV Primary 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 its replacement.

Mill Hill 33/11kV Primary S/S - T2 Refurbishment

The condition of Mill Hill T2 is such that refurbishment is required. The refurbishment is planned for 2014. There are plans to replace the transformer in 2017 due to load. Consideration should be given to bringing forward the replacement.

Colindale 132/11kV Grid Substation - Retrofit 11kV Switchgear

The condition assessment of the 1966/67 AEI BVRP1/JB425 indoor oil insulated switchgear installed at Colindale 132/11kV 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 its retrofit.

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3.3 Security of supply analysis

Substation	Demand (MW)	Supply Class	Demand (MVA)			P2/6	Comments
			2015	2018	2021		
Mill Hill / Elstree Group	275	D	286	325	339	Compliant	Becomes group E in 2017
Mill Hill 132	281	D	292	310	325	Compliant	
Elstree SGT8 & 9	275	D	286	325	339	Compliant	
Hendon 132	174	D	181	214	224	Compliant	

Table 2. P2/6 Assessment table (following completion of Elstree 132 and including LUL load on Hendon 132)

3.4 Operational and technical constraints

The 132kV bar at Mill Hill is run split in 2 sections with 1 x 240MVA and 1 x 180MVA on each section. It is planned to remove the switchboard at Mill Hill.

The new LUL Neasden load due to be connected to the Hendon 132kV bus bars under normal running conditions is 57MVA, however they also need to be able to take up to 90MVA when the UKPN network is under an n-1 scenario. Therefore the load that needs to be considered under normal running conditions is 57MVA, the load that needs to be considered under an n-1 scenario is 90MVA and the load that needs to be considered under an n-2 scenario is 57MVA.

Within this RDP area there are cable bridges in the following locations:

- Colindale: 3 x 33kV cables and pilots.
- West Finchley: 1 x 11kV, 2 x 33kV oil filled cables and pilots.

3.5 National Grid

National Grid intends to replace the 132kV outdoor switchboard at Mill Hill but at the present it is unclear whether they intend to install an indoor switchboard or outdoor switchboard, however with the removal of the LUL load from Mill Hill it is proposed that the switchboard is replaced with separate local transformer feeder circuit breakers. National Grid also intends to replace one of the 180MVA transformers at Mill Hill with a 240MVA transformer, still teed off the 275kV circuits.

4 Recommended strategy

4.1 Description

Mill Hill Group

Mill Hill 132kV Supergrid – Replace 132kV switchboard with 4 x local transformer CBs

Mill Hill is equipped with 2 x 275/132kV, 240MVA transformers and 2 x 275/132kV 180MVA transformers connected to a 132kV outdoor switchboard. Currently also connected to the Mill Hill 132kV bar is 1 x 132kV cable to the 22kV London Underground substation at Neasden (a second supply is currently provided from the LPN Willesden substation), however LUL have recently accepted a quote to remove this supply (and the supply from Willesden) and install a new 132kV supply from Hendon 132 via 2 x 132kV circuits. When the LUL Neasden supply is removed from the Mill Hill bars it is likely that UKPN will be required to adopt the bars.

Joint NG/UK Power Networks assessment of the existing structures and CBs (single phase bulk oil) suggest that full replacement of the switchboard will be required with design commencing in 2016.

With a new 132kV double bus bar at Hendon Grid fed from 2 of the Mill Hill circuit breakers and Finchley Grid transformers fed from the remaining 2 circuit breakers there is no need for a double bus switchboard at Mill Hill. It is proposed to remove the 132kV switchboard and install 4 x transformer local circuit breakers instead. The

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circuit breakers will most likely remain National Grid assets, therefore it is anticipated they will be installed at National Grids cost.

Finchley 132/33kV Grid Substation - Load transfer (transfer Bellevue Primary to Hendon Grid)

The predicted load on Finchley Grid substation will approach the existing site firm capacity within the ED1 period. Whilst it is possible to increase the capacity at the site, a more economical solution would be to transfer Bellevue Primary to Hendon Grid substation. This will also improve the 33kV interconnection capacity between Finchley and Hendon and the ability manage loads under network fault conditions.

East Finchley 33/11kV Primary Substation - ITC (2 x 20/40MVA)

The load at East Finchley is predicted to exceed the site firm capacity. It is proposed to replace the existing 2 x 20MVA transformers with 2 x 33/11kV, 20/40MVA transformers. The 11kV switchboard will also be replaced within the scope of this project.

Kingsbury 33/11kV Primary Substation - 11kV Load transfer

The load on Kingsbury will exceed the firm capacity of the site. It is proposed to transfer load at 11kV from Kingsbury Primary onto Kenton Primary.

Brockenhurst/Mil Hill 33/11kV Primary Substations - ITC (2 x 12/18/24MVA) and 11kV Network Reinforcement

The predicted load at Brockenhurst / Mill Hill single transformer substations group will exceed the existing firm capacity, including 11kV load transfers. It is therefore proposed to replace the existing 1 x 15MVA transformer at both sites with larger units and increase the interconnection between the two sites. The existing switchgear is fully rated for this increased load. The existing circuits supplying the transformers are fully rated for the larger units.

Elstree SGT 8 & 9 Group

Stanmore Grid / Kenton Primary 33kV Fluid Filled Cables - 33kV FFC Replacement

The condition assessment of the Stanmore Grid / Kenton Primary 33kV Fluid Filled Cables 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 CI and CML performance therefore this project recommends the replacement. Completion of the project will see 0.85 km of 33kV Fluid Filled Cables replaced.

Innovation: Demand Side Response

Studies have been undertaken to identify suitable sites for participation in smart demand response to reduce peak load with a view to delay proposed reinforcement work. These studies identified a Demand Side Response intervention as an option to defer the reinforcement of a primary substation in this RDP.

4.2 Financial Appraisal and Benefits

Information regarding Load Indices and Health Indices as part of OFGEM output measures is available in the Appendices.

The financial expenditure is shown in the Appendices.

5 Rejected Strategies

5.1 Mill Hill/Hendon area reinforcement

Mill Hill 132kV Grid Supply Point

- Replace the 132kV double bus switchboard with a new double bus outdoor switchboard (£6.2m)

Replace the existing 132kV outdoor double bus switchboard with a new outdoor double bus switchboard. The switchboard would be run in 2 sections with the centre bus section breakers run open.

- Replace the 132kV double bus switchboard with a new double bus indoor switchboard (£11.5m)

Replace the existing 132kV outdoor double bus switchboard with a new indoor double bus switchboard. The switchboard would be run in 2 sections with the centre bus section breakers run open.

- Replace the 132kV double bus switchboard with a single bus switchboard (£8.2m)

Replace the existing 132kV double bus 132kV switchboard with a new indoor single bus, 4 section switchboard. The switchboard would be run in 2 sections with the centre bus section breaker run open.

Finchley 132/33kV Grid Substation

- ITC (3 x 90MVA) and 33kV cable (£7m)

Install a new 132/3kV 90MVA transformer and 132kV cable circuit from Mill Hill 132. A new 132kV circuit breaker will also be required at Mill Hill. The new transformer will be connected to the existing 3 section, 33kV bar at Finchley Grid.

Mill Hill 33/11kV Primary Substation

- ITC (2 x 12/24MVA), half 11kV switchboard and improved 11kV interconnection (£1.3m)

Install a 2nd 33/11kV, 12/24MVA transformer at Mill Hill Primary and a half 11kV switchboard to increase the transformer capacity available to the Mill Hill/Brockenhurst group. The new transformer at Mill Hill will be connected to the 33kV circuit to Stanmore Grid. The RMU at Mill Hill will be run open on the Stanmore side of the RMU.

Manns Rd 33/11kV Primary Substation

- Stonegrove ITC (1 x 12/24MVA, 1 x 15MVA) and improved 11kV interconnection (£2.6m)

Install a 33/11kV, 12/24MVA transformer (in addition to the existing 15MVA transformer) at Stonegrove Primary. The new transformer at Stonegrove will be connected to a new 33kV circuit to Stanmore Grid. Additional 11kV interconnection between Stonegrove and Manns Rd will be installed to reduce the load on Manns Rd. The switchboard is due to be replaced in 2015.

6 References

References	Description
Reference 1	Planning Load Estimates EPN Area
Reference 2	132kV Network HV Schematic Operating Diagrams East of England (date)
Reference 3	33kV Network HV Schematic Operating Diagrams East of England (date)
Reference 4	Barnet Local Plan (Core Strategy) September 2012
Reference 5	Current and forecast asset health information (HI) as per 2013 RIIO-ED1 submission

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

6.1 Appendices

Appendix	Description
Appendix A	Geographical diagram
Appendix B	Single Line Diagram – Existing Network
Appendix C	Single Line Diagram – Recommended Strategy
Appendix D	Detailed costs for recommended strategy
Appendix E	Output Measures – Load Index Table (LI)
Appendix F	Output Measures – Health Index Table (HI)
Appendix G	Generation Heat Map

6.2 Document History

Version	Date of Issue	Author	Details
1.0	21/03/2013	Paul Ramsbotham	Updated for Peer Review.
1.1	24/06/2013	Paul Ramsbotham	Updates to reflect new position for RIIO-ED1
1.2	14/03/2014	Paul Ramsbotham	Updated with 19 th February 2014 NAMP, EPN HI List and latest LI information

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
Paul Ramsbotham	Infrastructure Planner		19/03/14
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

Approval by:

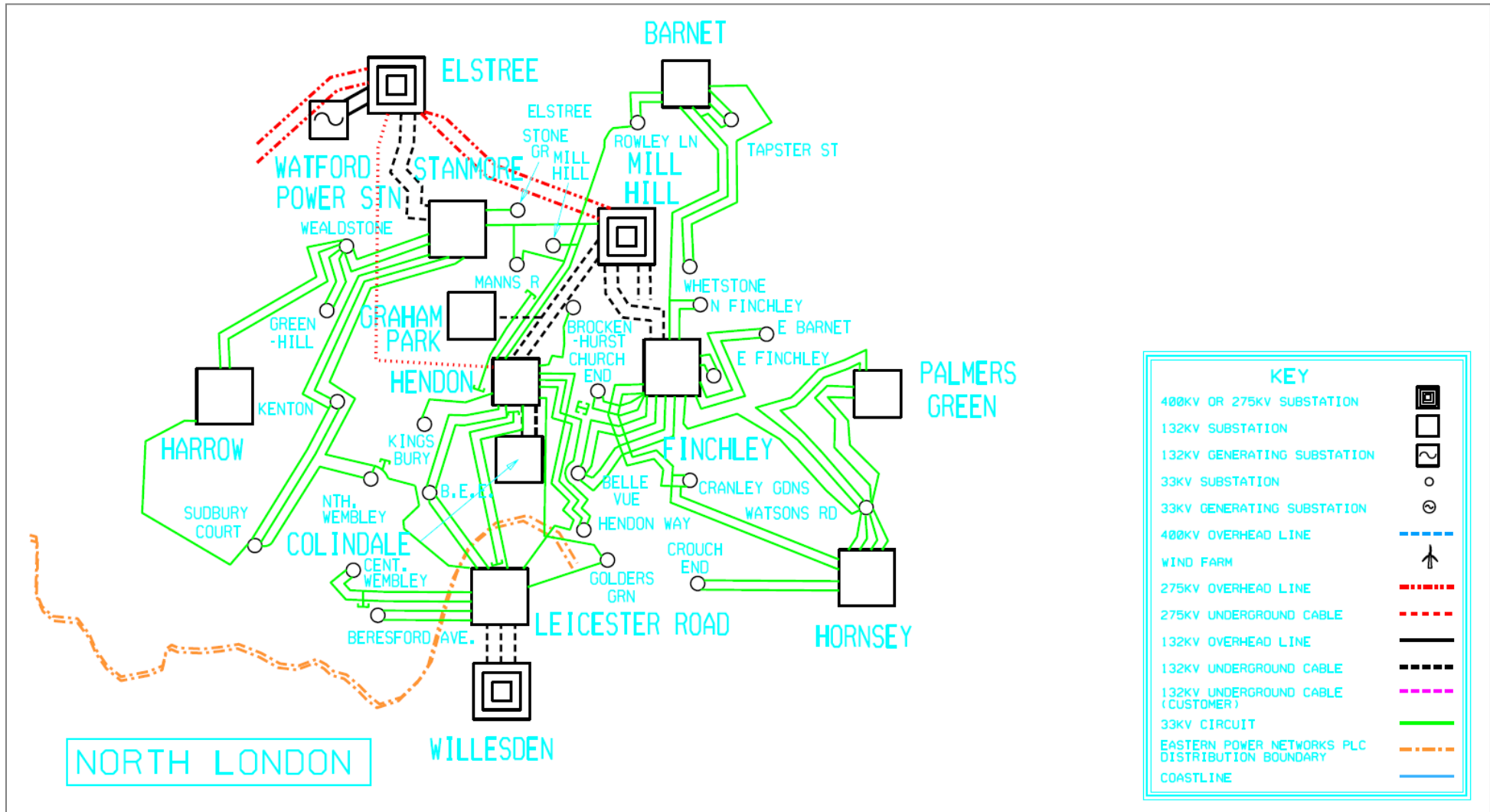
Name	Role	Signature	Date
Robert Kemp	Head of System Development		20/03/14
Barry Hatton	Director of Asset Management		

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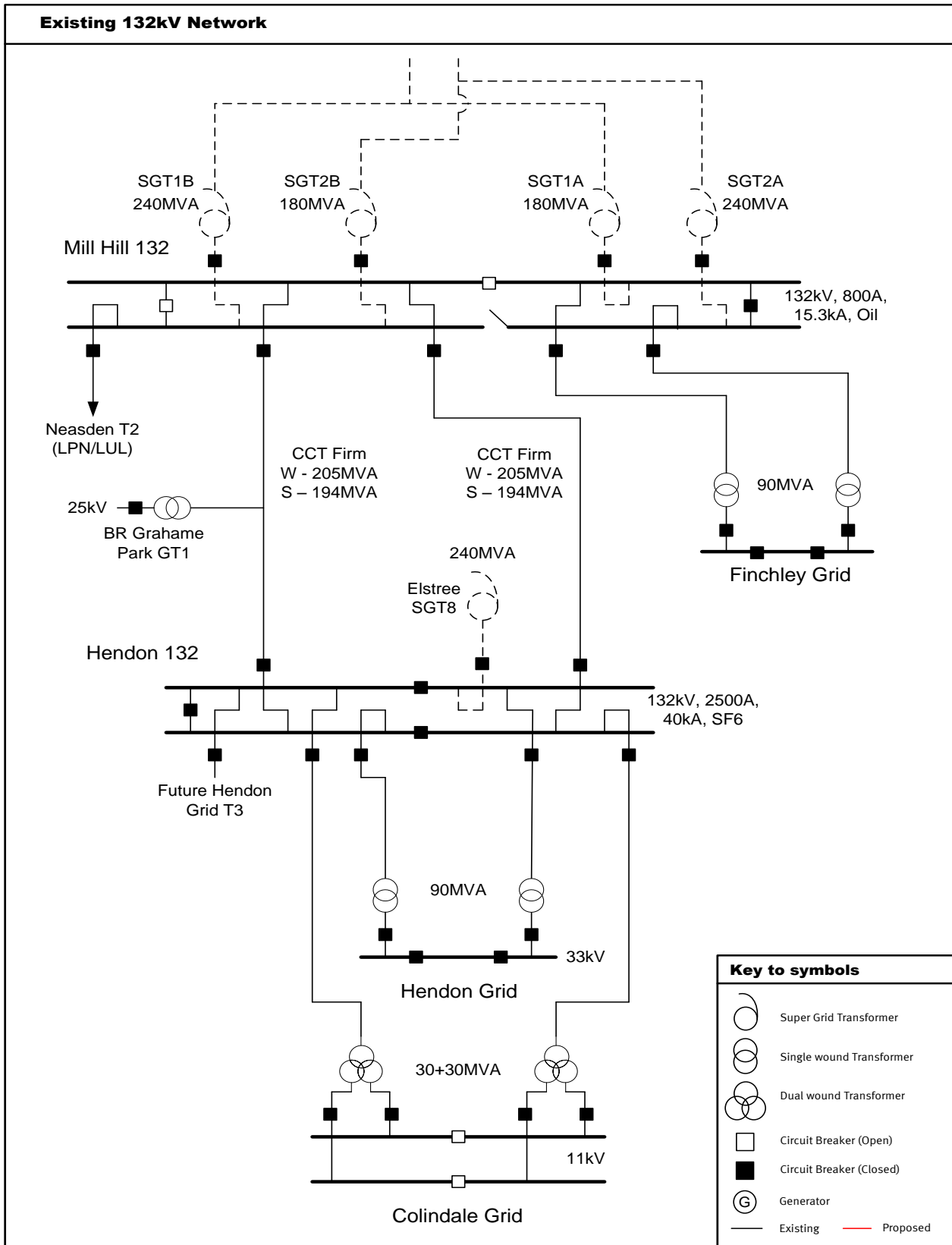


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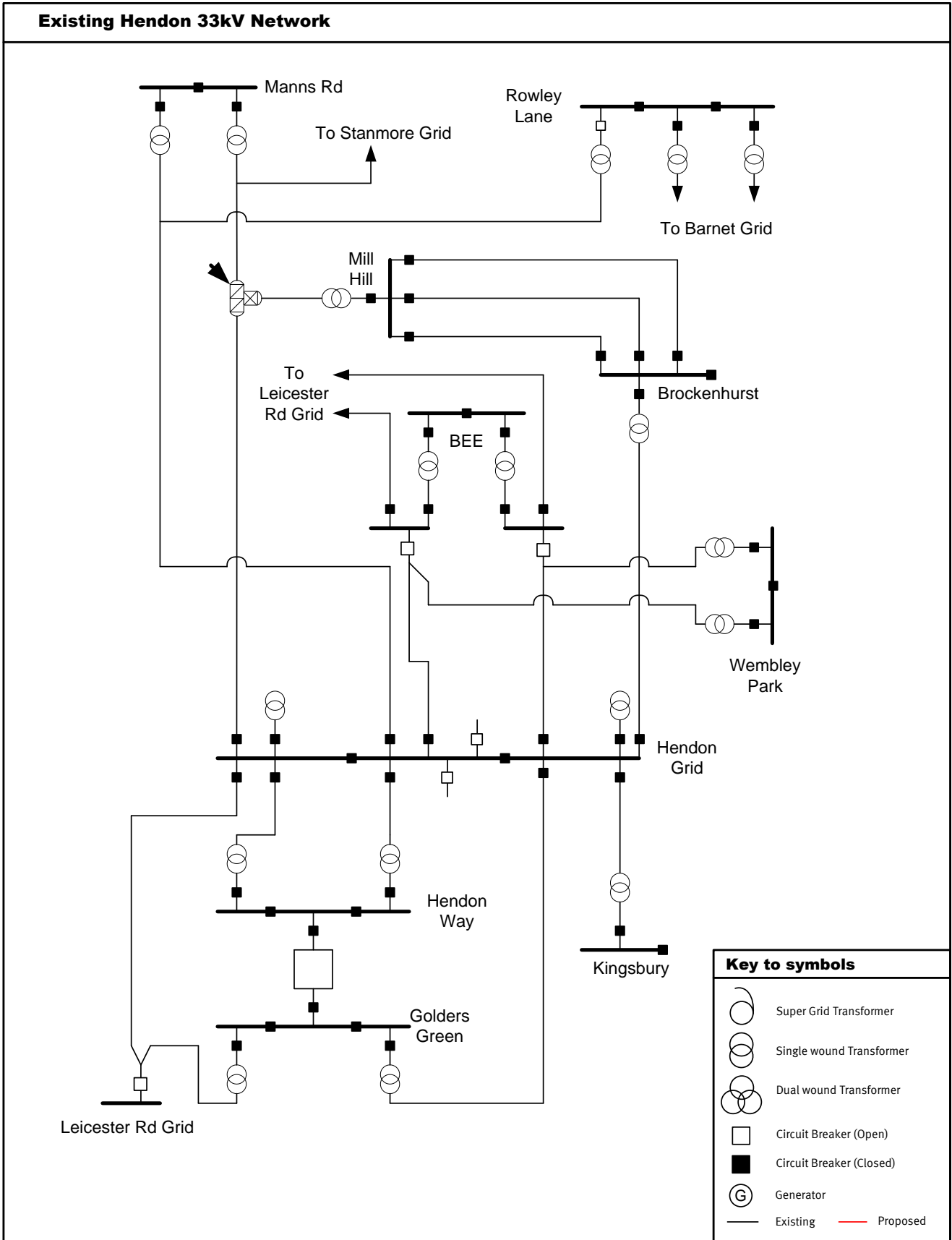
APPENDIX A: GEOGRAPHICAL DIAGRAM

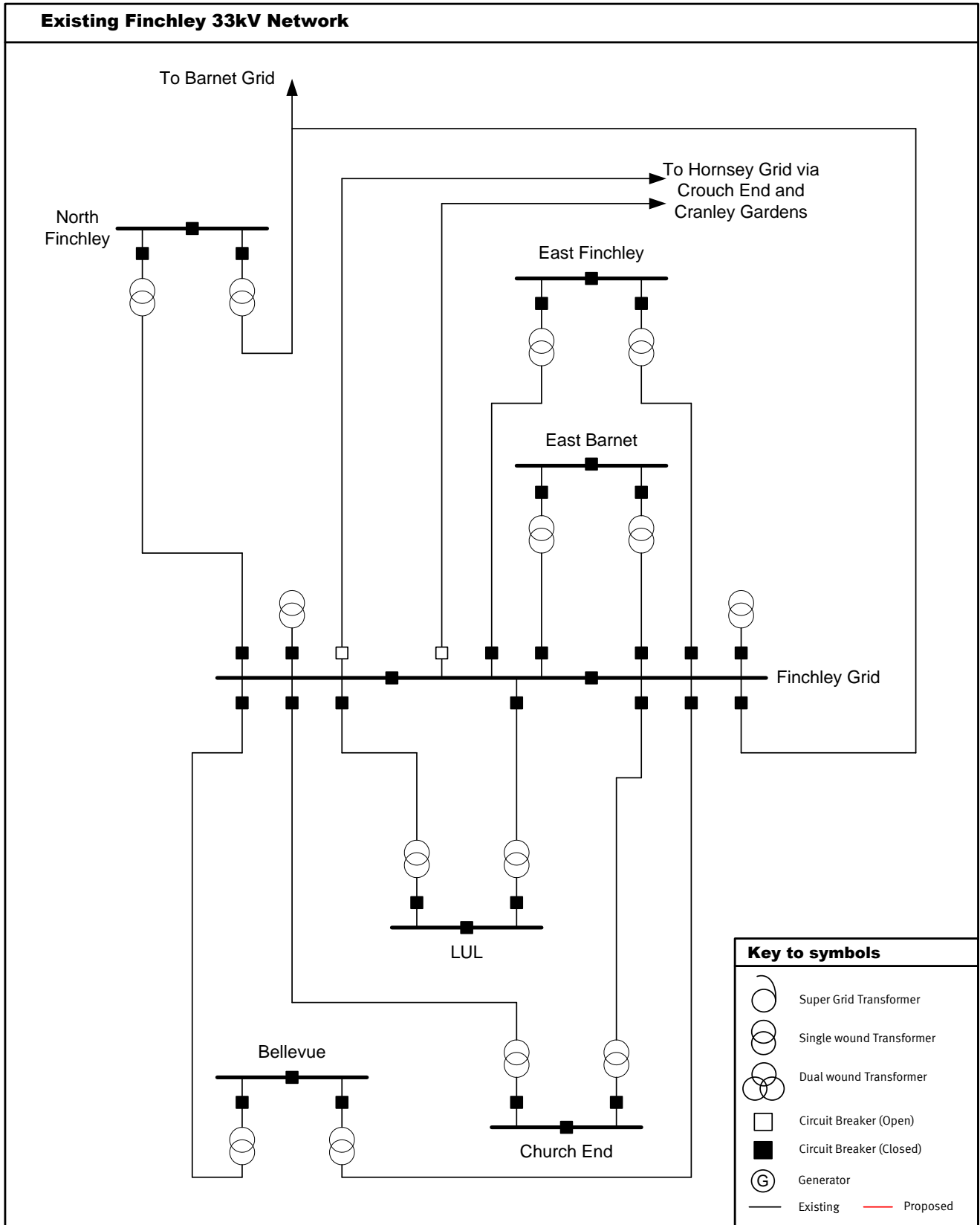


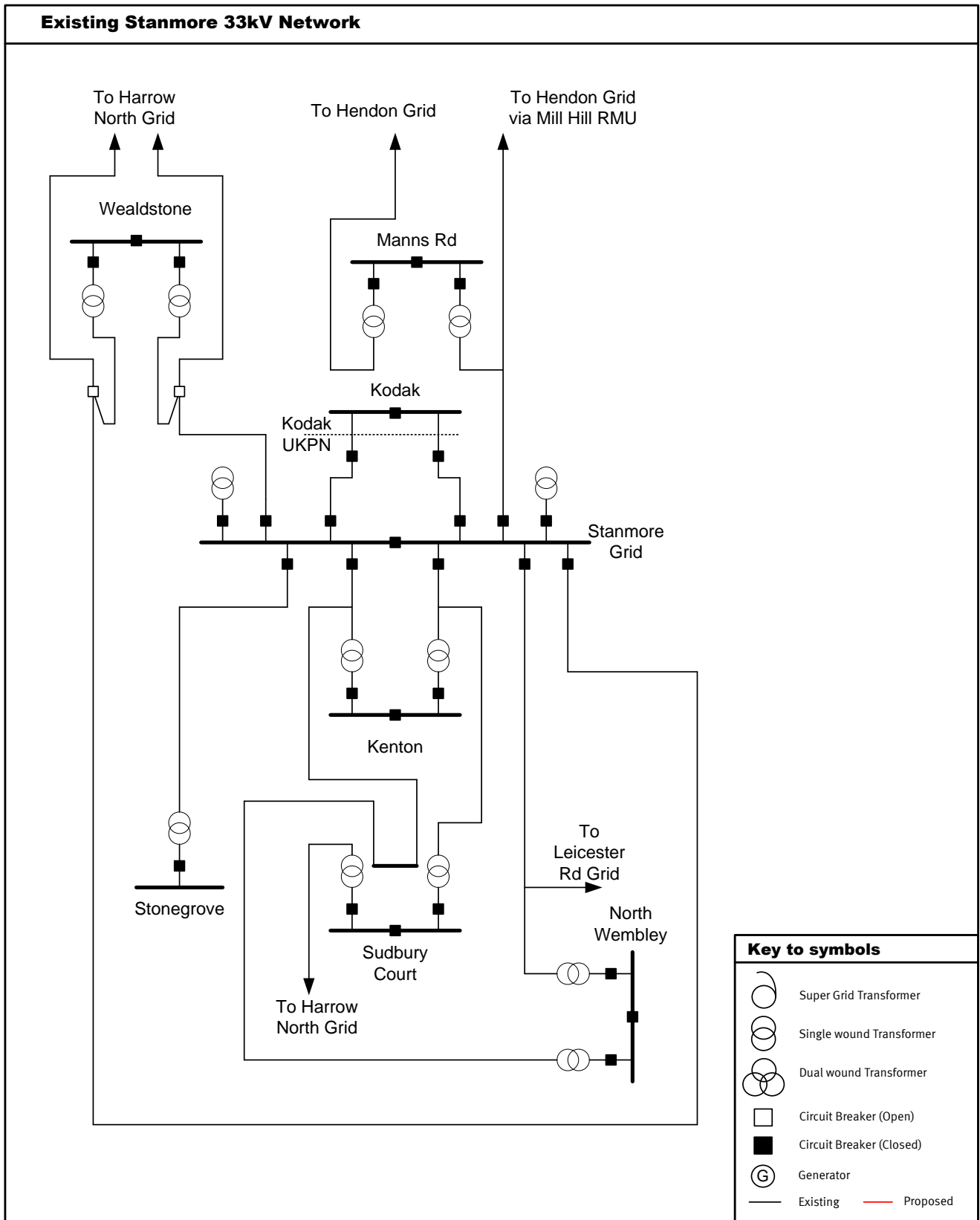
APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK



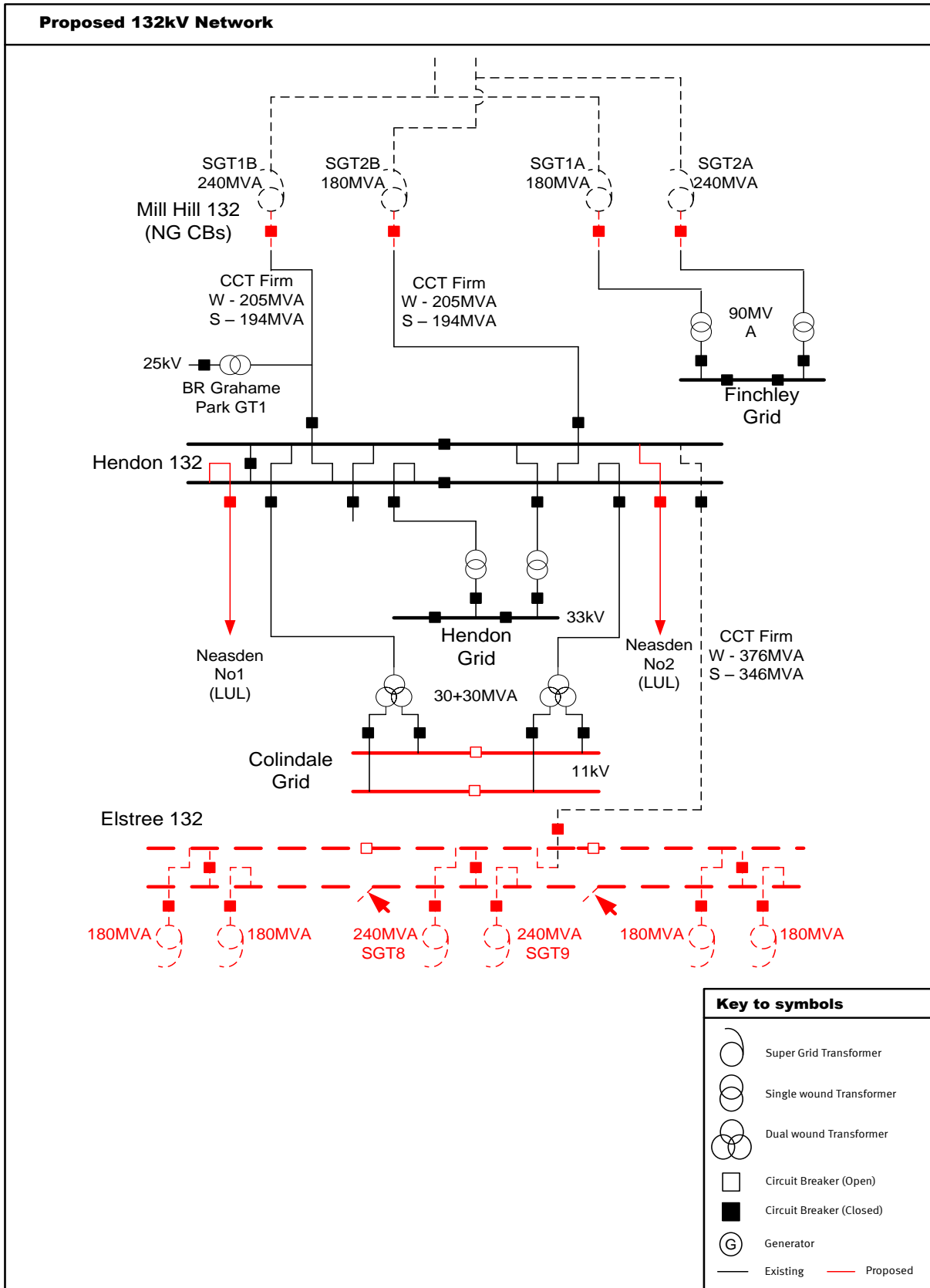
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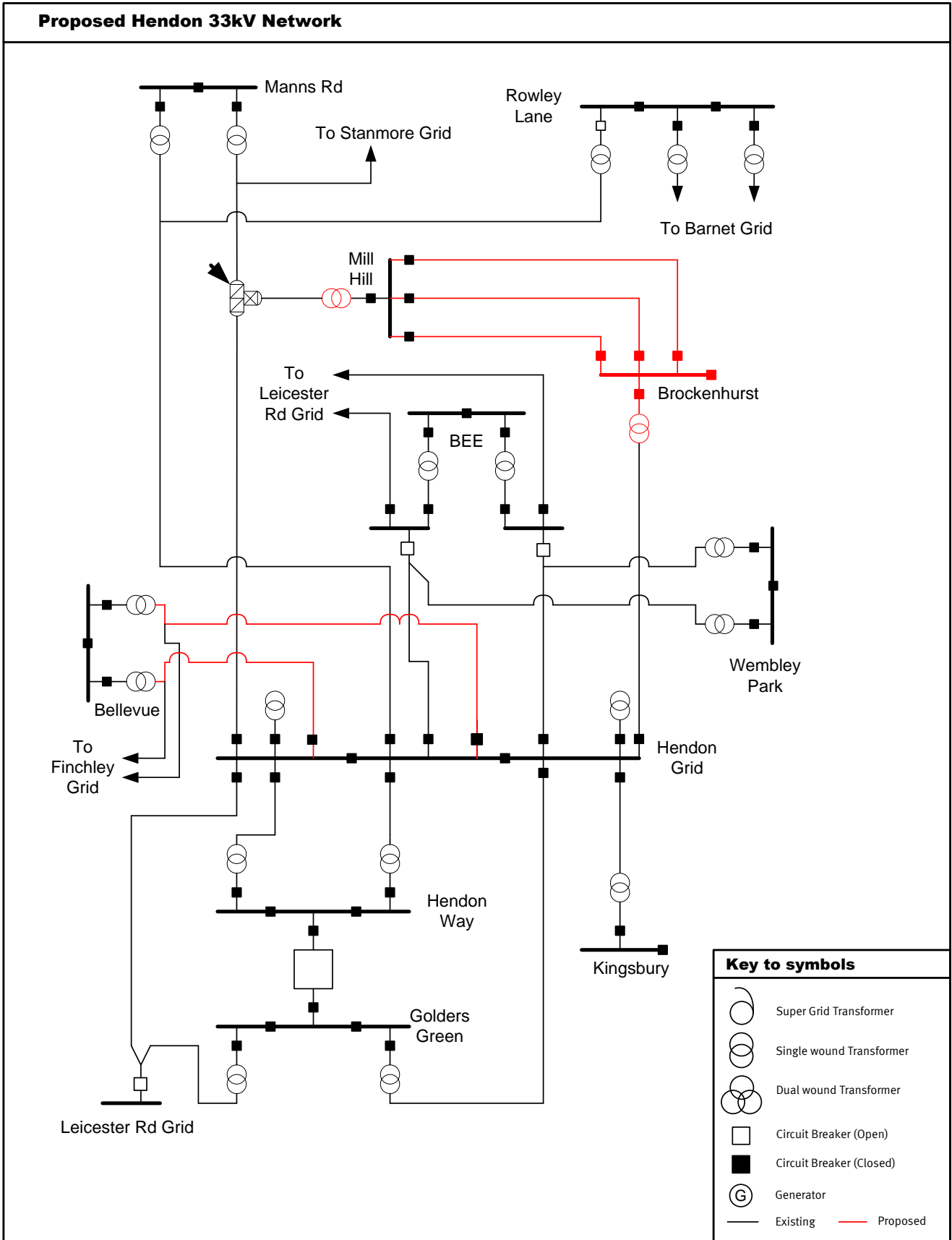


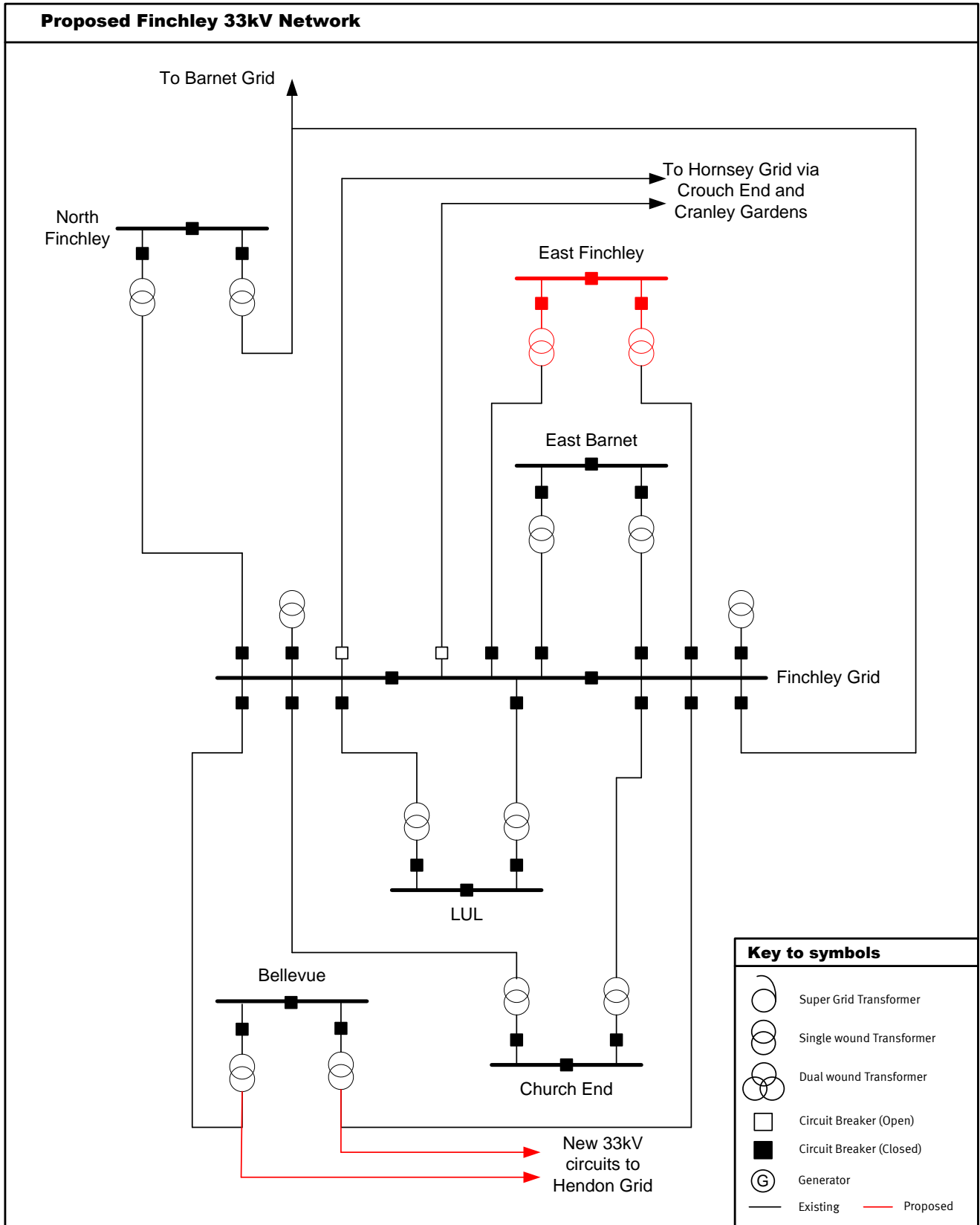


APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY

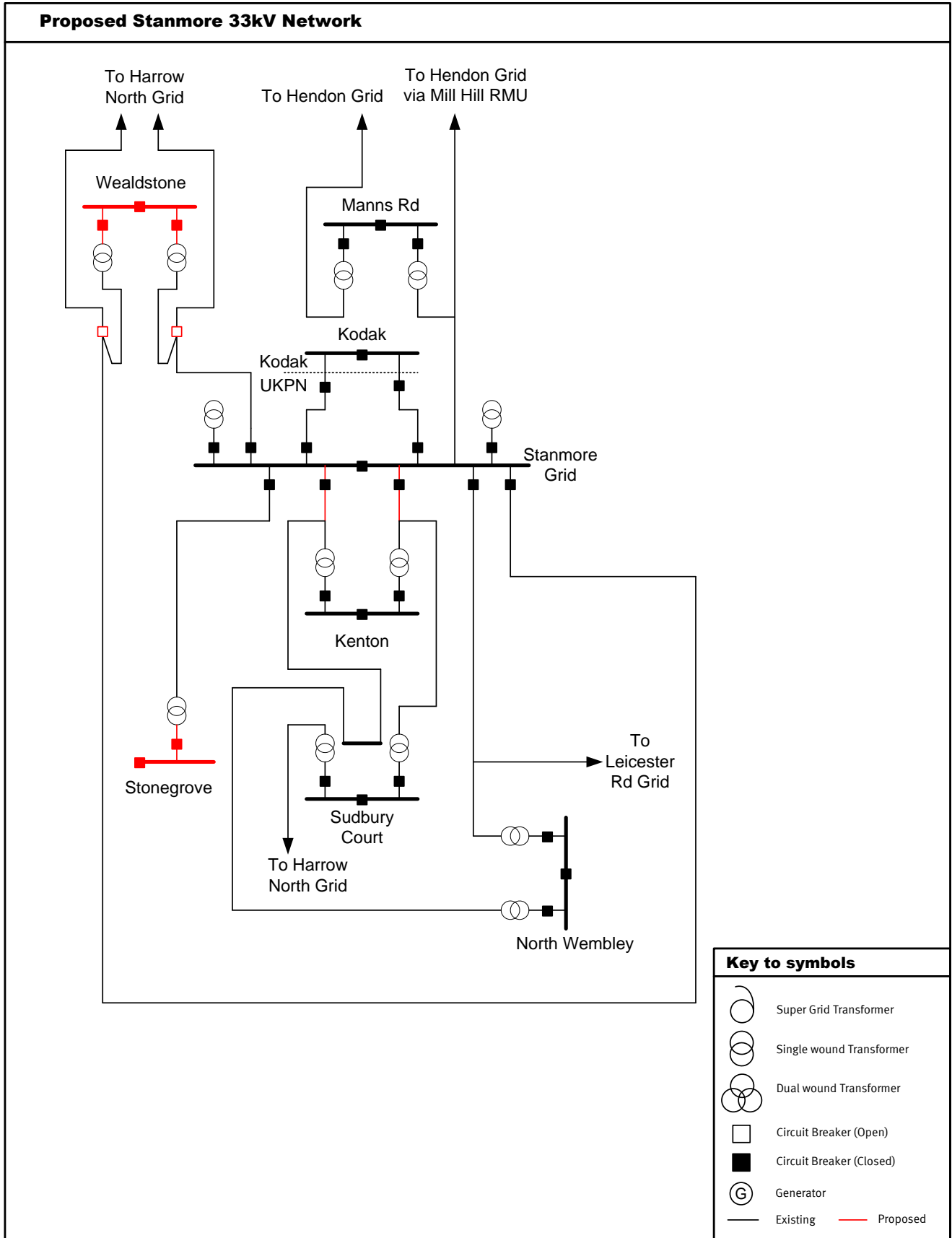


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APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19-02-2014

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.20.09	8462	Manns Rd 33/11kV Primary - 11kV Switchboard Replacement (Asbestos Removal)	15,000									
A	1.47.08	8341	Manns Rd 33/11kV Primary - Demolish Redundant Buildings	14,271									
A	1.48.02	2399	Wealdstone 33/11kV Primary Substation - Replace 33kV Switchgear				210,034						
A	1.48.06	2307	Mill Hill 132kV Grid Supply Point - Replace 132kV Switchgear (NG*)					1,034,860	2,932,104	973,309			
A	1.48.11	2960	Hendon 132/33kV Grid Substation - Replace Switchboard (2500A)	1,360,044									
A	1.50.01	2464	Brockenhurst 33/11kV Primary Substation - Replace 11kV Switchgear			234,836	555,099						
A	1.50.01	2467	Cranley Gardens 33/11kV Primary Substation - Replace 11kV Switchgear							253,523	672,178		
A	1.50.01	2470	Kingsbury 33/11kV Primary Substation - Replace Switchboard (2000A)	19,999									
A	1.50.01	2471	Manns Road 33/11kV Primary Substation - Replace 11kV Switchboard (2000A)	647,022									
A	1.50.01	2477	Wealdstone 33/11kV Primary Substation - Replace 11kV Switchgear				279,043	673,398					
A	1.50.01	7629	Arnos Grove 33/11kV Primary Substation - Replace 11kV Switchgear									40,026	930,421
A	1.50.01	7675	Colindale 132/11kV Grid Substation - Retrofit 11kV Switchgear									408,160	
A	1.50.01	7706	Stonegrove 33/11kV Primary Substation - Replace 11kV Switchgear		43,068	697,926							
A	1.51.11	5836	Mill Hill 33/11kV Primary S/S - T2 Refurbishment	145,000									
H	1.29.01	7596	Stanmore Grid / Kenton Primary 33kV Fluid Filled Cables - 33kV FFC Replacement		100,695	363,701							

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DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19-02-2014

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
H	1.29.02	2780	Elstree-Stanmore 132kV FFC replacement	2,019,455	1,129,348								
R	1.11.02	2496	Mill Hill Barracks - Diversion of Mill Hill to Hendon/Nesden 132kV Circuits	1,449,429									
R	1.33.01	5407	Hendon Way 33/11kV Primary Substation - Switchgear Replacement (2000A) & Golders Green ITC (1x 12/18/24MVA)	1,882,832									
R	1.33.01	5408	East Finchley 33/11kV Primary Substation - ITC (2x 20/30/40MVA) and 11kV Switchboard				357,825	954,200	730,179				
R	1.33.01	5710	BEE 33/11kV Primary Substation - Demand Side Response (DSR)						7,625	30,500	30,500	30,500	30,500
R	1.33.01	6191	Brockenhurst/Mil Hill 33/11kV Primary Substations - ITC (2 x 12/18/24MVA) and 11kV Network Reinforcement				393,694	1,085,247					
R	1.34.02	6189	Kingsbury 33/11kV Primary Substation - 11kV Load Transfer to Kenton Primary			96,666	239,871						
R	1.37.06	2302	Hendon Grid 132kV Substation- Exit Point Reinforcement	52,622									
R	1.37.07	5465	Leicester Road/BEE 33kV Cable Route - Wembley Tunnel Completion	333,925									
R	1.37.07	6186	Finchley 132/33kV Grid Substation - Load Transfer (Transfer Bellevue Primary to Hendon Grid)								271,448	887,656	668,479

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APPENDIX E: OUTPUT MEASURES – LOAD INDICES (LI)

PLE information to Table CV102 (LI) – Ofgem definition and Element Energy growth forecast.

Substation	Season	First Limitation	FC NOW (MVA)	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention			P2/6 End of ED1	
				NAMP	FC ED1 Start (MVA)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	NAMP	Driver	2022 (S) 22/23 (W)	P2/6 Class	Comply
Bee	W	Circuit Rating	30.8	5465	38.1	27.8	41.3	LI1	LI4	5710	38.1	LI4	C	Yes
Bellevue	W	Transformer	26.0		26.0	19.2	20.6	LI1	LI1		26.0	LI1	C	Yes
Beresford Avenue	W	Transformer	18.0		18.0	11.3	12.6	LI1	LI1		18.0	LI1	C	Yes
Brockenhurst T1	W	Backfeed	8.5		8.5	9.6	10.1	LI5	LI5	6191	24.0	LI1	B	Yes
Central Wembley	S	Transformer	22.5		22.5	12.6	13.5	LI1	LI1		22.5	LI1	C	Yes
Church End	W	Transformer	19.5		19.5	17.5	17.5	LI2	LI2		19.5	LI1	C	Yes
Colindale	W	Transformer	72.0		72.0	37.2	37.7	LI1	LI1		72.0	LI1	C	Yes
East Barnet	W	Transformer	13.0		13.0	9.1	11.5	LI1	LI2		13.0	LI2	B	Yes
East Finchley	W	Transformer	26.0		26.0	23.8	25.7	LI2	LI3	5408	40.0	LI1	C	Yes
Finchley Grid 33	W	Transformer	117.0		117.0	99.2	109.6	LI2	LI2	6186	117.0	LI2	D	Yes
Golders Green	W	Transformer	19.5		22.3	19.0	20.5	LI2	LI2		22.3	LI2	C	Yes
Hendon Grid 33	W	Switchgear	114.3	2960	117.0	72.1	78.2	LI1	LI1		117.0	LI1	D	Yes
Hendon Way	S	Transformer	18.0	5407	25.0	19.5	21.2	LI1	LI2		25.0	LI2	C	Yes
Kenton	W	Transformer	19.5		19.5	10.3	11.2	LI1	LI1		19.5	LI1	B	Yes
Kingsbury T1	W	Backfeed	12.7		12.7	11.5	12.6	LI2	LI3		12.7	LI3	C	Yes
Leicester Road 33	S	Transformer	90.0		90.0	50.1	65.4	LI1	LI1		90.0	LI1	D	Yes
Manns Rd Total	S	Transformer	15.0		15.0	12.2	19.4	LI2	LI4		15.0	LI4	C	Yes
Mill Hill T2	W	Backfeed	8.5		8.5	11.0	11.6	LI5	LI5	6191	24.0	LI1	B	Yes

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OUTPUT MEASURES – LOAD INDICES (LI)

PLE information to Table CV102 (LI) – OFGEM definition and Element Energy growth forecast.

Substation	Season	First Limitation	FC NOW (MVA)	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention			P2/6 End of ED1	
				NAMP	FC ED1 Start (MVA)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	NAMP	Driver	2022 (S) 22/23 (W)	P2/6 Class	Comply
North Finchley	W	Transformer	38.0		38.0	24.7	27.1	LI1	LI1		38.0	LI1	C	Yes
North Wembley	W	Transformer	24.0		24.0	13.6	14.9	LI1	LI1		24.0	LI1	C	Yes
Stanmore Grid	W	Switchgear	38.1		38.1	26.6	28.7	LI1	LI1		38.1	LI1	C	Yes
Stanmore Grid 33	W	Switchgear	114.3		114.3	70.7	75.7	LI1	LI1		114.3	LI1	D	Yes
Stonegrove	W	Backfeed	13.8		13.8	10.7	11.3	LI1	LI2		13.8	LI2	B	Yes
Sudbury Court total	W	Transformer	19.5		19.5	14.0	14.9	LI1	LI1		19.5	LI1	C	Yes
Wealdstone	W	Switchgear	22.9		22.9	14.4	15.4	LI1	LI1	2477	25.8	LI1	C	Yes
Wembley Park	S	Transformer	26.5		26.5	15.6	27.8	LI1	LI4		26.5	LI4	C	Yes

APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

Substation	132kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
MILL HILL 132			3	1				1	1	2	4				
TOTAL			3	1				1	1	2	4				

Substation	33kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BEE PRIMARY	6					6					6				
FINCHLEY GRID		4	14					17	1				17	1	
HENDON GRID	16					16					16				
LEICESTER RD GRID	11	8				11	8				11	8			
MILL HILL PRIMARY	1					1					1				
STANMORE GRID	9	3					12					12			
WEALDSTONE PRIMARY				2						2	2				
TOTAL	43	15	14	2		34	20	17	1	2	36	20	17	1	

OUTPUT MEASURES - HEALTH INDICES

Substation	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BEE PRIMARY	17					17					17				
BELLEVUE PRIMARY		10	3					13					13		
BERESFORD AV PRIMARY		1	12					11	2				11	2	
BROCKENHURST PRIMARY			7	2					1	8	9				
CENTRAL WEMBLEY PRIMARY		6	3					8	1				8	1	
CHURCH END PRIMARY		10					5	5				5	5		
COLINDALE GRID		13	12					18	7			25			
EAST BARNET PRIMARY		5	6					11					11		
EAST FINCHLEY PRIMARY	4		3	10		4			3	10	17				
GOLDERS GRN PRIMARY	13					13					13				
HENDON WAY PRIMARY	20					20					20				
KENTON PRIMARY	9					9					9				
KINGSBURY PRIMARY	9					9					9				
MANNS RD PRIMARY					14					14	14				
MILL HILL PRIMARY		7					7					7			
NORTH FINCHLEY PRIMARY		2	10					12					12		
NORTH WEMBLEY PRIMARY	14					14					14				
STANMORE GRID		9	6				2	13				2	13		
STONEGROVE PRIMARY			5	1					1	5	6				
SUDBURY COURT PRIMARY	12					12					12				
WEALDSTONE PRIMARY			13	1				3	5	6	14				
TOTAL	98	63	80	14	14	98	14	94	20	43	154	39	73	3	

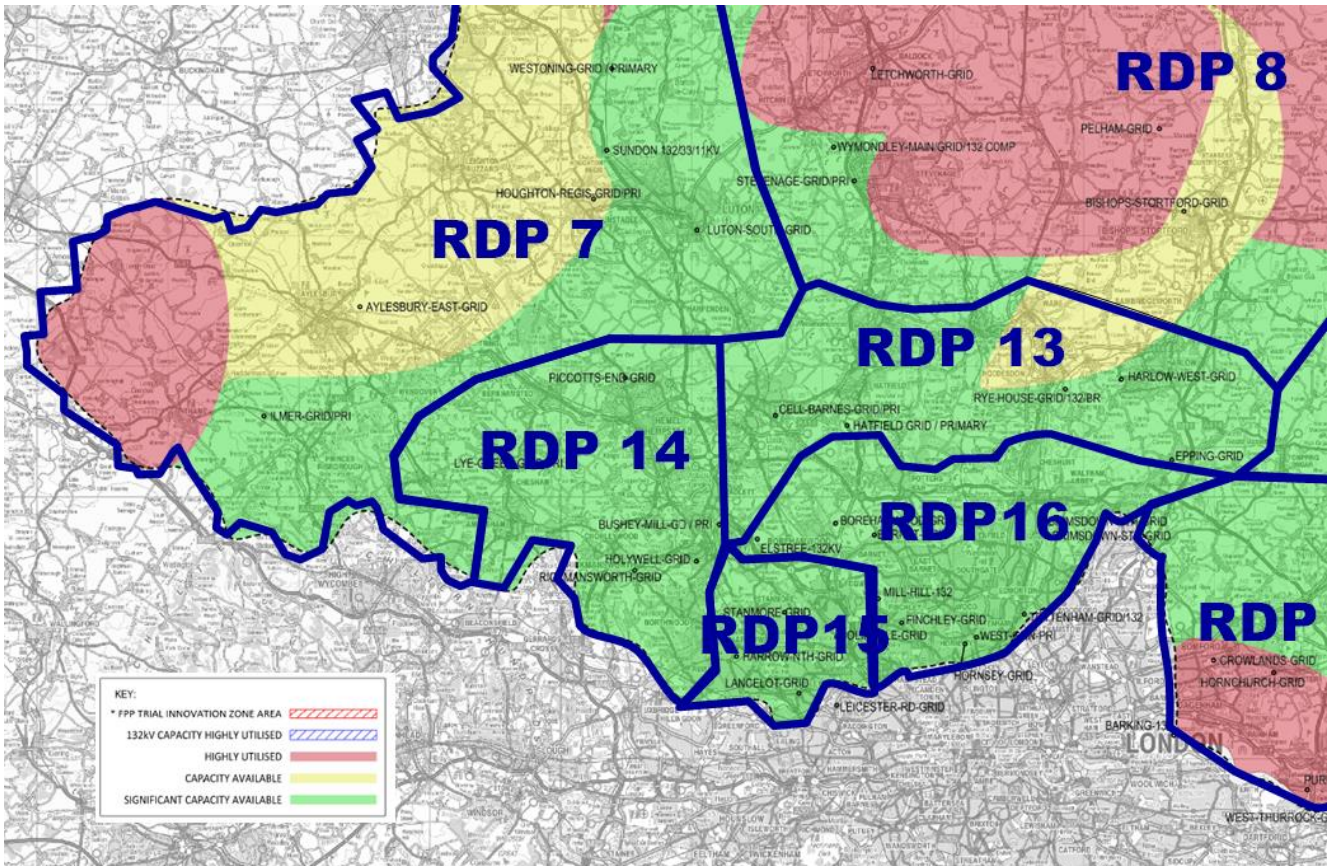
OUTPUT MEASURES - HEALTH INDICES

Substation	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BEE PRIMARY		2					2					2			
BELLEVUE PRIMARY		2					2					2			
BERESFORD AV PRIMARY		2						2					2		
BROCKENHURST PRIMARY		1					1				1				
CENTRAL WEMBLEY PRIMARY		2					2					2			
CHURCH END PRIMARY		2					2					2			
COLINDALE GRID		2						2					2		
EAST BARNET PRIMARY		1	1					1	1				1	1	
EAST FINCHLEY PRIMARY		1			1			1		1	2				
FINCHLEY GRID		2						2					2		
GOLDERS GRN PRIMARY			1	1					1	1		2			
HENDON GRID		1	1					2					2		
HENDON WAY PRIMARY		2					1	1				1	1		
KENTON PRIMARY		2						2					2		
KINGSBURY PRIMARY		1					1					1			
MANNS RD PRIMARY		2						2					2		
MILL HILL PRIMARY				1						1	1				
NORTH FINCHLEY PRIMARY		2						2					2		
NORTH WEMBLEY PRIMARY	2						2					2			
STANMORE GRID		4					1	3				1	3		
STONEGROVE PRIMARY		1						1					1		
SUDBURY COURT PRIMARY		2						2					2		
WEALDSTONE PRIMARY		2					1	1				1	1		
TOTAL	2	36	3	2	1		15	24	2	3	4	16	23	1	

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APPENDIX G: GENERATION HEAT MAP

The heat map presented in this page is indicative of the capability of the high voltage electrical network to accept connection of new generation equipment. The area in red indicates that the network in that area is effectively at saturation point with respect to generation connections. The amber and green areas indicate parts of the network that currently have limited and spare capacity to connect new generation equipment at HV or above.



Eastern Power Networks Generation Capacity Map 14-01-2014