Annesley, Clipstone and Mansfield BSPs

Network Development Report – East Midlands

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Electricity Distribution

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Contents

Annesley / Clipstone / Mansfield 33 kV

1. Network Overview

Annesley, Clipstone and Mansfield Bulk Supply Points (BSPs) are fed from Chesterfield Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. Mansfield BSP is fed directly from Chesterfield GSP, with Clipstone and Annesley being fed via Mansfield and Pinxton BSPs respectively.

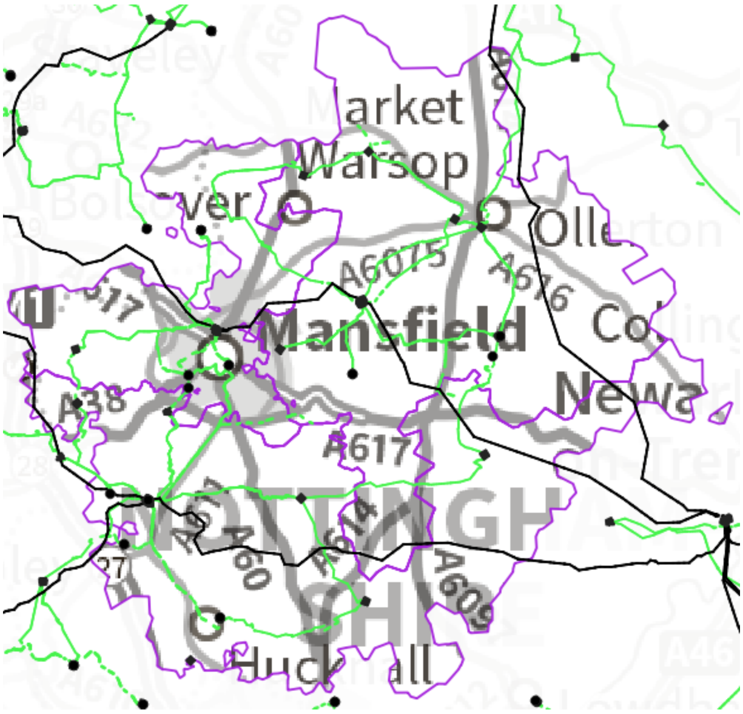

Figure 1.1 Annesley, Clipstone and Mansfield geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the Grid Transformers (GTs) and the 33 kV network fed from Annesley, Clipstone and Mansfield BSPs. This uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios. Five representative days have been studied across the four seasons: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

Annesley BSP has four 33 kV busbars fed by four 132/33 kV GTs. GT1 and GT2, which feed the main 1 and main 2 33 kV busbars respectively are rated to 22.5/45/58.5 MVA. GT3 and GT4, which feed the main 3 and main 4 33 kV busbars respectively are rated to 30/60/78 MVA. Annesley BSP feeds eight primary substations: Annesley, Blidworth, Calverton, Farnsfield, Hucknall, Huthwaite, Sherwood Park and Sutton Junction T1/T2. Annesley primary is located at the same site as Annesley BSP. All of the primaries fed from Annesley have two 33/11 kV transformers and are fed via a circuit from each side of Annesley BSP (GT1/2 and GT3/4), with the exceptions of Sutton Junction (which has a third transformer fed from Mansfield BSP) and Farnsfield (which is a single transformer primary fed via Blidworth primary). Calverton primary is run split at 11 kV under normal running arrangements.

There are two 33 kV cables between the main 2 and main 3 33 kV busbars which form an interconnector between the two halves of Annesley which is normally run open. Annesley BSP is interconnected with Mansfield BSP via Sutton Junction, Teversal and Skegby Lane primaries, with Alfreton BSP via Blackwell primary, with Heanor BSP via Westwood primary and with Clipstone BSP via Farnsfield primary (all of which are normally run open).

Clipstone BSP has two 33 kV busbars fed by two 132/33 kV GTs both rated to 45/90/117 MVA. Clipstone BSP feeds eight primary substations: Bilsthorpe, Budby, Clipstone, Crown Farm, Ollerton, Rufford, Thoresby and Warsop. Clipstone primary is located at the same site as Clipstone BSP. Budby is a single transformer primary, with the other seven primaries having two 33/11 kV transformers each. Clipstone BSP is interconnected with Checkerhouse BSP via a normal open point at Ollerton primary and with Annesley BSP as described above.

Mansfield BSP has two 33 kV busbars fed by two 132/33 kV GTs both rated to 45/90/117 MVA. Mansfield BSP feeds six primary substations: Acreage Lane, Lime Tree Place, Mansfield, Skegby Lane, Sutton Junction T3 and Teversal. Mansfield primary is located at the same site as Mansfield BSP. All of the primaries fed from Mansfield BSP, with the exception of Sutton Junction, have two 33/11 kV transformers. Mansfield BSP is interconnected with Annesley BSP as described above.

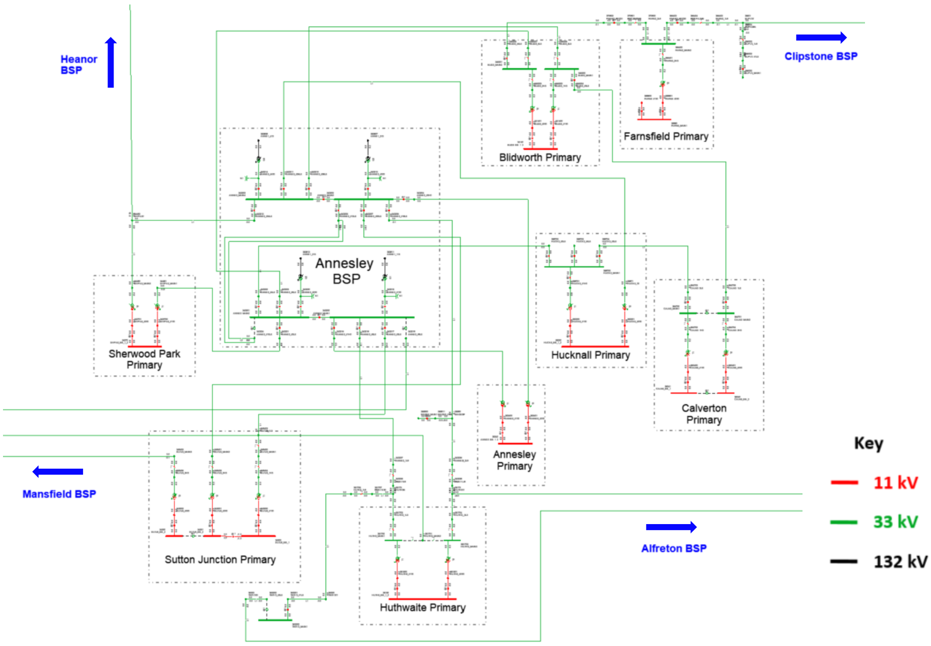

Figure 1.1.1 Annesley 33 kV network single line diagram

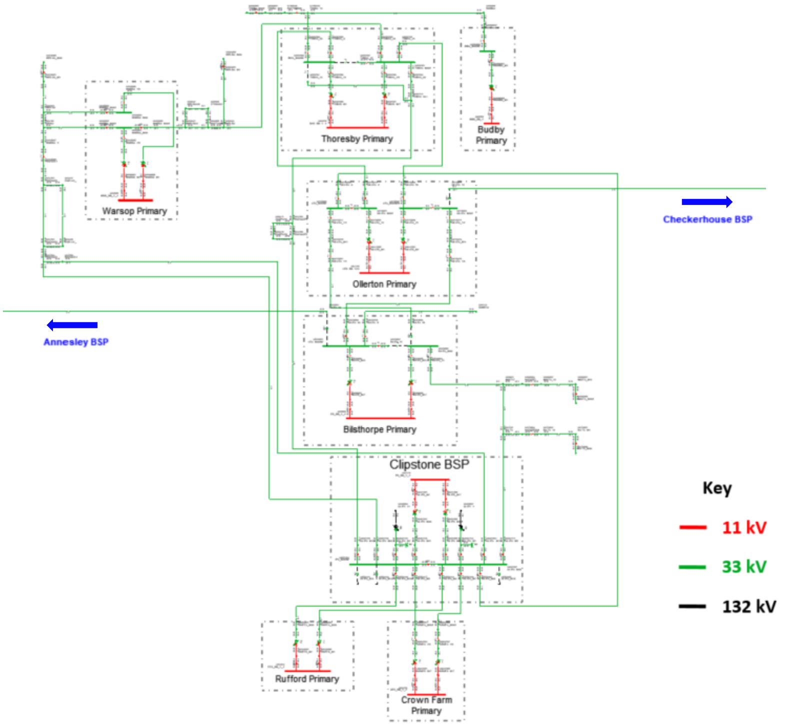

Figure 1.1.2 Clipstone 33 kV network single line diagram

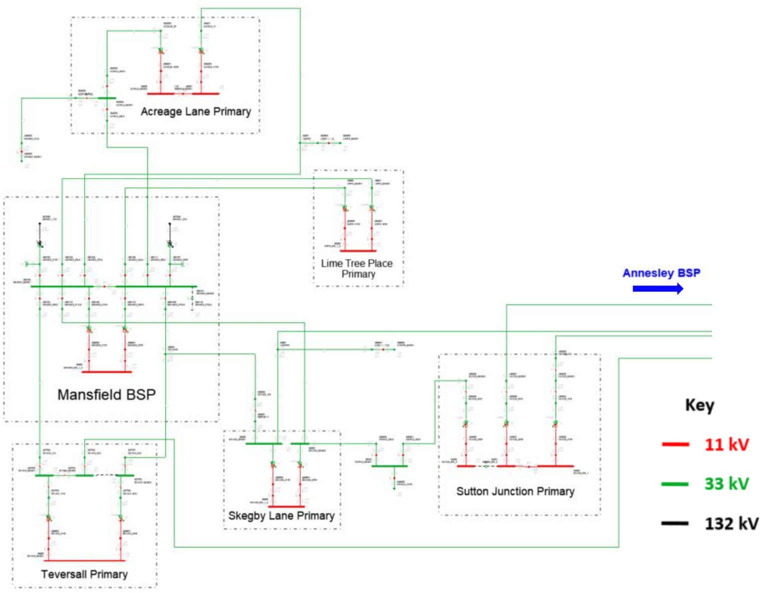

Figure 1.1.3 Mansfield 33 kV network single line diagram

1.2 Network Operability Modelling

The following network automation and manual switching schemes have been modelled in the analysis of this area, aligning to how the network is currently operated, as well as proposed actions to manage some constraints identified operationally or to account for proposed network changes.

- The 33 kV network downstream of Clipstone and Mansfield BSPs are split for an outage on their respective 33 kV bus section breakers to prevent loose couples. For Mansfield this involves splitting Mansfield primary, Skegby Lane, Teversal, Lime Tree Place and Acreage Lane (all of which are fed from both bars) at 11 kV. For Clipstone this involves splitting Clipstone primary, Crown Farm, Rufford, Bilsthorpe, Warsop, Thoresby and Ollerton (all of which are fed either directly or indirectly from both bars) at 11 kV, as well as CB11 at Clipstone 33 kV.

- For an outage on any GT or 33 kV busbar (or either of the 33 kV bus section breakers) at Annesley BSP the downstream network is split between the two halves on Annesley to prevent loose couples. This involves splitting some combination of Annesley primary, Sherwood Park, Huthwaite, Sutton Junction, Hucknall and Blidworth at 11 kV. Alternatively Annesley can paralleled via the interconnection between the main 2 and main 3 33 kV busbars (but this cannot be done for an outage on either of these two busbars).
- For an outage on either infeed to Calverton the primary is paralleled at 11 kV (and at 33 kV if possible).
- Farnsfield primary is transferred into Clipstone BSP for an outage on the infeed from Annesley BSP at 33 kV. For an outage on the transformer at Farnsfield the load is transferred on the 11 kV network to Southwell and Bilsthorpe primaries.
- For an outage on the infeed to Sutton Junction T3 from Mansfield, the primary is paralleled at 11 kV to maintain supply from Annesley BSP on T1 and T2.
- For an outage on the direct 33 kV infeed to Bilsthorpe primary from Clipstone BSP, or on the Clipstone-Ollerton 33 kV circuit the second 33 kV circuit from Bilsthorpe to Ollerton (which is normally run open) is closed.
- For a 33 kV busbar outage at Clipstone BSP, or an outage on any of the Bilsthorpe – Ollerton, Ollerton-Thoresby or Thoresby-Clipstone circuits Bilsthorpe primary is paralleled at 33 kV.
- For an outage on the Ollerton-Thoresby main 1 circuit or main 1 at Clipstone BSP, Thoresby primary is paralleled at 33 kV.
- For a busbar outage on Thoresby main 1 the circuit from Thoresby main 2 to Ollerton is opened.
- For an outage on the infeed to Budby primary from Thoresby the load is transferred on the 11 kV network to Warsop primary.
- For the loss of an infeed to a transformer at any of the primaries fed from Annesley, Mansfield or Clipstone BSPs under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- Various generators are disconnected for arranged outages on their 33 kV infeeds to prevent backfeeding.
- For the proposed Annesley reconfiguration with three GTs, if an arranged outage is taken on any of the three GTs the remaining two are split (with one GT feeding main 1 and main 2 and the other feeding main 3 and main 4).
- For either of the two Annesley reconfigurations discussed with two 132/33 kV GTs, the four 33 kV busbars are run parallel under normal running arrangements, with the appropriate primaries split for 33 kV bus section or busbar outages.
- For the two and three GT Annesley configurations, for a 33 kV bus section breaker outage on either side of Annesley the appropriate primaries are split. Primaries are no longer split for an outage on any GT as there are no loose couples between the two halves of Annesley BSP in the proposed configuration.
- The potential new primary substation fed from Annesley BSP would be split for bus section breaker outages and its LV circuit breakers opened for outages on either infeed (as with all existing two transformer primaries).
- Further analysis is required for potential new running arrangements on the Clipstone 33 kV network.

2. Network Constraints and Solution Options

2.1 Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options will be discussed:

- Overloads are seen on the GTs at Annesley BSP for certain potential reconfigurations following the planned asset replacement and rationalisation.
- Overloads are observed on T1 and T2 at Sutton Junction primary for an outage at Mansfield BSP or on the circuit from Mansfield BSP to Sutton Junction T3 followed by a fault on one of the Annesley – Sutton Junction 33 kV circuits.
- Overloads are seen in 2034 on the transformers and infeed circuits to Huthwaite primary for an arranged or fault outage on the other transformer/infeed.
- Overloads are seen in 2028 on the GTs at Mansfield BSP for an arranged or fault outage on the other GT.
- Overloads are seen in 2028 on the transformers at Mansfield primary for an arranged or fault outage on the other transformer/the 33 kV busbars at Mansfield BSP.
- For an arranged or fault outage on the main 1 busbar at Mansfield BSP the demand of Teversal and Skegby Lane primaries is supplied by a single 33 kV circuit from Mansfield BSP to the Skegby Lane tee. In 2034 overloads are seen on this section of circuit for this outage condition.
- Overloads are seen in 2028 on the section of 33 kV circuit supplying the main 1 busbar at Skegby Lane primary for an arranged or fault outage on the other 33 kV infeed to Skegby Lane at times of peak generation.
- Two of the 33 kV circuits from Clipstone BSP are non-compliant with Engineering Recommendation P18 regarding circuit complexity, restricting new connections on the 33 kV network.

2.2 Annesley BSP GT overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis. The GTs and primary transformers at Annesley BSP are due for asset replacement based on their condition, so the constraints identified below are based on the possible reconfigurations following the replacement of the GTs.

Table 2.2.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Annesley GT overloads (under option 1)	GT or 33 kV busbar arranged or fault outage	None	2034	2028	2028	2034
Annesley GT overloads (under option 2)	GT or 33 kV busbar arranged or fault outage	None	-	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: Regardless of scenario the GT configurations outlined in options 1 and 2 would not be suitable for the growth projected at Annesley BSP in the long term. The GT configuration outlined in option 3 will provide enough GT capacity for the growth projected at Annesley until at least 2034 under even the higher growth scenarios (Leading the Way and Consumer Transformation).

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.2.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Install two 132/33 kV GTs and rationalise Annesley BSP.
2	Install two 132/33 kV and two 132/11 kV GTs and rationalise Annesley BSP.
3	Install three 132/33 kV GTs and rationalise Annesley BSP.
4	Replace the four 132/33 kV GTs with the existing configuration.
Flexibility Services	
5	Procure flexibility under Annesley BSP.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full Cost Benefit Analysis (CBA). This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution.

Option 1 – Install two 132/33 kV GTs and rationalise Annesley BSP

Discounted

Capacity released for constraint(s) considered: Reduction in capacity

New limiting factor for constraint(s) considered: New GT ratings

Detailed description: The four 132/33 kV GTs and the two 33/11 kV primary transformers at Annesley BSP are due for replacement based on their condition. This provides an opportunity to economically rationalise the BSP to improve its operability and ensure there is sufficient capacity available for demand and generation growth in the future.

The rationalisation of Annesley BSP would involve moving 33 kV feeders to remove all loose couples between the two halves of Annesley (main 1/2 and main 3/4), with the exception of Calverton primary which is normally run open. The proposed rationalisation would have the primaries fed from Annesley split as follows:

- Main 1/2: Sutton Junction, Sherwood Park, Hucknall and Calverton T2.
- Main 3/4: Annesley primary, Huthwaite, Blidworth, Farnsfield and Calverton T1.

This proposed split balances the load roughly evenly between the two halves of Annesley based on current loadings. Demand forecasts for 2034 indicate demand will still be split quite evenly. This split leaves ample capacity on the main 1/2 side of Annesley to accept the demand from Sutton Junction T3 as discussed in Section 2.5 of this report. Calverton primary will also provide a small amount of transfer capacity between the two halves of Annesley as it will be able to be fed from either side.

In this option the existing four GTs would be replaced with two 60/90/117 MVA 132/33 kV units, and the existing two primary transformers would be replaced with two 20/40 MVA 33/11 kV units. This options reduces the overall capacity of Annesley BSP such that overloads are observed by 2028 and in all seasons by 2034 as shown in the table above. This option has therefore been discounted as not long after works would be completed a third GT would be required, incurring further costs and requiring additional resources and outages to go back into Annesley BSP.

Option 2 – Install two 132/33 kV and two 132/11 kV GTs and rationalise Annesley BSP

Discounted

Capacity released for constraint(s) considered: Dependent on load balance between 33 kV and 11 kV networks

New limiting factor for constraint(s) considered: New 132/33 kV GT ratings

Detailed description: As in option 1, this proposal would include rationalising Annesley BSP to split the loose couples and balance the load between main 1/2 and main 3/4. In this option, as well as installing two 132/33 kV GTs as in option 1, the primary transformers at Annesley BSP would be replaced with 132/11 kV GTs. This would take the local 11 kV load at Annesley BSP off the 33 kV network and free up capacity on the new 132/33 kV GTs.

This option has been discounted as although capacity is freed up on the 132/33 kV GTs, it is not sufficient to prevent overloads being seen by 2034. This option would therefore not be a strategic use of investment as four GTs would need to be installed but less capacity created than the three GT solution discussed below. Additionally, once capacity runs out again on the 132/33 kV GTs there would be no easy way to develop Annesley further as there would already be four GTs in the 132 kV compound.

Option 3 – Install three 132/33 kV GTs and rationalise Annesley BSP

Viable

Capacity released for constraint(s) considered: Up to 98 MVA

New limiting factor for constraint(s) considered: Limited by 132 kV circuit capacity from Chesterfield GSP (how limited will depend on growth at Pinxton BSP and two large accepted battery connections)

Detailed description: In this option, as with the previous two options, the 33 kV circuits out of Annesley BSP would be rationalised, but three 132/33 kV GTs would be installed rather than two. Two of these GTs would feed either side of Annesley BSP, with the third set up in the middle on a swing arrangement such that it can feed onto main 1, main 4 or both.

The three GTs would be run parallel under normal running arrangements, and split with one GT feeding either side of Annesley for an arranged GT outage. This allows each side of Annesley BSP to be loaded up to the rating of one GT. To fully utilise the GT capacity being installed Annesley will need to be well balanced, highlighting the importance of the rationalisation works described in option 1. The three GTs at Annesley BSP will also be installed in a way which leaves the option open to install a fourth at some point in the future. This fourth GT would not add significant GT capacity, but would provide the option to split Annesley into effectively two BSPs (which may be required at some point in the future to reduce the group load of the Annesley/Pinxton group or deload the 132 kV circuits back to Chesterfield).

Option 4 – Replace the four 132/33 kV GTs with the existing configuration

Discounted

Capacity released for constraint(s) considered: Dependent on primary growth split

New limiting factor for constraint(s) considered: GT capacity under 33 kV busbar outages

Detailed description: In this option the four GTs at Annesley BSP would be replaced with 60/90/117 MVA units in the existing configuration. This option has been discounted as it would require significant expenditure as four GTs would be required but would not provide any of the benefits of rationalisation discussed in options 1-3 above, and would leave the BSP significantly worse in terms of network operability. The GT capacity being installed would also not be able to be fully utilised as for certain outages the demand at Annesley BSP would be impossible to split evenly (most notably main 2 or main 3 busbar outages as they would disconnect a number of primaries from one side of Annesley, and prevent the 33 kV interconnector from being closed).

Option 5 – Procure flexibility under Annesley BSP

Discounted

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads on the GTs at Annesley BSP. As replacing the transformers at Annesley BSP is being triggered by their condition flexibility is unsuitable for deferring this constraint.

Solution Recommendation

As discussed above there are significant benefits to rationalising Annesley BSP, and installing three GTs is the most cost effective way to add significant capacity to Annesley for future growth. Option 3 is therefore the most strategic option, and also leaves room for future development of Annesley (the installation of a fourth GT).

2.3 Sutton Junction T1 and T2 overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis. The primary transformers T1 and T2 at Sutton Junction are also due for replacement based to their condition. This replacement will provide an economic opportunity to uprate the transformers to prepare Sutton Junction for future projected load growth. T3 at Sutton Junction (which is fed from Mansfield BSP) is not currently due for asset replacement so would be maintained as it is.

Table 2.3.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Sutton Junction T1 or T2 overload	Arranged outage on the Sutton Junction T3 infeed from Mansfield	Fault on either 33 kV Annesley – Sutton Junction circuit	-	2028	-	-

Uncertainty under other Distribution Future Energy Scenarios: There is no scenario under which the projected load growth at Sutton Junction primary takes it over 38 MVA by 2050, and no scenario under which the load growth is not over 23 MVA by 2040. Thus the option outlined below is robust and low regret.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.3.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Replace the transformers at Sutton Junction with 20/40 MVA units.
2	Replace the transformers at Sutton Junction with 12/24 MVA units.
Operational Mitigation	
3	Various operational mitigations.
Flexibility Services	
4	Procure flexibility under Sutton Junction primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution.

Option 1 – Replace the transformers at Sutton Junction with 20/40 MVA units

Viable

Capacity released for constraint(s) considered: 1-2 MVA dependent on season

New limiting factor for constraint(s) considered: 33 kV circuits from Annesley BSP and 11 kV switchgear

Detailed description: As noted above, T1 and T2 at Sutton Junction primary are due for asset replacement based on their condition. If 20/40 MVA units were used for T1 and T2 this would provide the option of removing T3 when it does come up for asset replacement and leaving Sutton Junction as a two transformer site (with the added benefit of shifting demand out of Mansfield BSP as discussed in Section 2.5 of this report). By installing 20/40 MVA units significant option value is created as if load growth is greater than expected (or economic opportunities to transfer demand at 11 kV and deload other primaries are identified) then the option of retaining T3 is still available.

To fully unlock the capacity created at Sutton Junction primary the 33 kV circuits from Annesley BSP and the 11 kV board would both also need uprating to match the 20/40 MVA transformers, but analysis indicates this would not be required before 2034 under the Best View scenario. If the circuits to Sutton Junction were uprated further (or the existing circuits retained and two new 33 kV circuits built), then the possibility of feeding a new primary via Sutton Junction could be opened up. This could reduce overall 33 kV circuit works required, but has been discounted as forecasts indicate that the load centre will be around Huthwaite primary (which is 4 km from Sutton Junction, with the area between the two primaries being quite urban).

Option 2 – Replace the transformers at Sutton Junction with 12/24 MVA units

Discounted

Capacity released for constraint(s) considered: Reduction in capacity

New limiting factor for constraint(s) considered: primary transformer ratings

Detailed description: By replacing T1 and T2 with 12/24 MVA units at Sutton Junction primary the capacity of the substation would be reduced. Overloads would then be observed by 2028 as with the existing transformers (shown in the table above). Although these overloads could be managed by the operational mitigations described below in the short term this would not be a long term solution. Given the similar cost of uprating to 20/40 MVA units as described in option 1 (and the associated discussed benefits provided) this option has been discounted.

Option 3 – Various operational mitigations

Viable

Capacity released for constraint(s) considered: Dependent on mitigation

New limiting factor for constraint(s) considered: As before

Detailed description: There are a number of operational mitigation options for managing this constraint, each of which could be sufficient to manage this constraint up to 2034:

- Restrict outage seasons: as this constraint is only present for an N-2 scenario at intermediate cool peak demand, restricting outage seasons to any of the other three seasons would mitigate this constraint. One disadvantage of this option is that it reduces network operability.
- Transfer demand on the 11 kV network for an outage on the infeed to T3 at Sutton Junction. If this demand was transferred on the 11 kV network to nearby primaries instead of being transferred onto T1 and T2, this constraint would be mitigated. This option is reliant on sufficient transfer capacity being available on the 11 kV network.
- Review seasonal ratings: as this constraint is only present in intermediate cool (the ratings for which may be overly pessimistic as they align to the summer rating), an internal review of transformer seasonal ratings may conclude that this constraint is not present in 2028/34.

Option 4 – Procure flexibility under Sutton Junction primary

Discounted

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads on Sutton Junction T1/T2. As replacing the transformers at Sutton Junction primary is being triggered by their condition flexibility is unsuitable for deferring this constraint.

Solution Recommendation

As the replacement of T1 and T2 is being triggered by their condition uprating them to 20/40 MVA units is the most economic and strategic solution to this constraint. Uprating the circuits from Annesley BSP to Sutton Junction primary is not required in the short term. If required before the transformers are replaced (or after to manage any possible constraints on the circuits) then some of the operational mitigations described in option 3 could be employed (restricting outage seasons and/or transferring demand at 11 kV).

2.4 Huthwaite transformer and circuit overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.4.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Huthwaite T1 or T2 overload	Arranged or fault outage on either transformer or circuit to Huthwaite primary	None	2034	2034	2034	2034
Huthwaite 33 kV infeed circuit overload	Arranged or fault outage on either transformer or circuit to Huthwaite primary	None	2034	2034	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: As under Best View, this constraint is present in 2034 under the Leading the Way and Consumer Transformation scenarios. Under the lower growth scenarios (System Transformation and Falling Short) intervention may not be required by 2034.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.4.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers and circuits to Huthwaite primary.
2	Install a third transformer at Huthwaite primary.
Flexibility Services	
3	Procure flexibility under Huthwaite primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 1 – Uprate the transformers and circuits to Huthwaite primary

Viable

Capacity released for constraint(s) considered: 14 MVA

New limiting factor for constraint(s) considered: Transformer rating

Detailed description: Overloads are observed on both the transformers and 33 kV feeder circuits to Huthwaite primary by 2034, necessitating intervention for both sets of assets. This could involve uprating both the transformers and 33 kV circuits to Huthwaite, which would resolve this constraint. 20/40 MVA transformers would be installed (the highest rated assets installed by NGED as standard on the network). This reinforcement solution would also benefit the condition of the existing transformers which are around 60 years old.

Option 2 – Install a third transformer at Huthwaite primary

Discounted

Capacity released for constraint(s) considered: 26 MVA

New limiting factor for constraint(s) considered: Rating of the existing transformers

Detailed description: Installing a third transformer at Huthwaite primary rated to 20/40 MVA would significantly increase the capacity at the substation. This would however necessitate a third 33 kV circuit to be built from Annesley BSP. This option has been discounted for a number of reasons:

- As noted above the existing transformers at Huthwaite are around 60 years old so will likely be due for asset replacement in the near future regardless.
- A third infeed from Annesley BSP would need to be fed from the other side of Annesley BSP to the existing two infeeds following the rationalisation discussed in Section 2.2 of this report (two feeders could not be fed from the same bar as for a busbar arranged/fault outage two infeeds to Huthwaite would be lost). This would create a loose couple across the two halves of Annesley BSP (which the rationalisation is aimed at avoiding, and would create problems if Annesley BSP were to be split in the future). The same problem of a loose couple would be created if Huthwaite primary T3 were to be fed from any other BSP (e.g. Alfreton or Mansfield).
- A three transformer primary site would present additional network operability issues (such as needing to split the 11 kV network for an arranged outage on any transformer/circuit).

Option 3 – Procure flexibility under Huthwaite primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the 33 kV circuits to and the primary transformers at Huthwaite. Utilising flexibility would not provide any benefit for the condition of the primary transformers at Huthwaite (however if the transformers were replaced based on their condition flexibility could still be used to defer 33 kV circuit works). The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement strategy is likely to be reinforcing the 33 kV circuits to and primary transformers at Huthwaite as outlined in option 1. This will both create significant capacity for load growth at Huthwaite and benefit the condition of the existing primary transformers.

2.5 Mansfield BSP GT overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.5.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Mansfield BSP GT1 or GT3 overload	Arranged or fault outage on either GT at Mansfield BSP	None	2034	2028	2034	2034

Uncertainty under other Distribution Future Energy Scenarios: This constraint occurs for other seasons in 2028 for the higher growth scenarios (Leading the Way and Consumer Transformation).

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.5.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the GTs at Mansfield BSP.
2	Install a third 132/33 kV GT at Mansfield BSP.
3	Build a new BSP.
4	Install two 132/11 kV GTs at Mansfield BSP.
Operational Mitigation	
5	Demand transfers.
6	Review seasonal ratings.
Flexibility Services	
7	Procure flexibility under Mansfield BSP.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the GTs at Mansfield BSP

Discounted

Capacity released for constraint(s) considered: N/A

New limiting factor for constraint(s) considered: As before

Detailed description: Uprating the 132/33 kV GTs at Mansfield BSP would alleviate this constraint. This option is not viable as the GTs are already the highest rating NGED uses on the network as standard. Utilising non-standard equipment creates a number of issues, such as finding replacements if serious faults occur.

Option 2 – Install a third 132/33 kV GT at Mansfield BSP

Viable

Capacity released for constraint(s) considered: Up to 114 MVA

New limiting factor for constraint(s) considered: 132 kV circuit capacity or N-2 group load depending on the load increase seen at Clipstone BSP

Detailed description: Installing a third GT at Mansfield BSP rated to match the existing two GTs would create significant additional capacity and resolve this constraint. This would require installing a third 33 kV busbar at Mansfield BSP (which would create additional 33 kV feeder capacity at Mansfield). This third GT could either be fed by a third 132 kV circuit from Chesterfield GSP or using a cross-bay setup.

A third 132 kV circuit from Chesterfield GSP would necessitate 17 km of circuit works (subject to detailed route investigation and land rights), making it the much more expensive option. However, it would provide additional security of supply and circuit capacity for the Mansfield-Clipstone group.

Option 3 – Build a new BSP

Discounted

Capacity released for constraint(s) considered: 114 MVA

New limiting factor for constraint(s) considered: Combined capacity of Mansfield BSP and the new established BSP

Detailed description: Establishing a new BSP near to Mansfield BSP would provide significant additional capacity and resolve the constraint at Mansfield BSP if suitable transfers were made to deload Mansfield BSP. This option has been discounted as it would be significantly more expensive than the other options discussed, and would not provide much extra capacity.

The other BSPs in close proximity to Mansfield (Annesley around 8 km away and Clipstone around 6.5 km away) would not benefit from this new BSP significantly either. In the case of Annesley significant GT capacity will be created by the works discussed in Section 2.2 of this report and in the case of Clipstone the demand growth projected does not warrant this level of investment (there is still projected to be GT capacity at Clipstone by 2034).

Option 4 – Install two 132/11 kV GTs at Mansfield BSP

Viable

Capacity released for constraint(s) considered: The 11 kV demand at Mansfield

New limiting factor for constraint(s) considered: As before

Detailed description: In this option two 132/11 kV GTs would be installed at Mansfield BSP, replacing the existing primary transformers. This would remove the 11 kV load at Mansfield from the 132/33 kV GTs and alleviate this constraint at least up to 2034.

The benefits of this option are strengthened by the fact that a large proportion of the growth forecast within Mansfield BSP is on the 11 kV network (at present around 30% of the load at Mansfield BSP is fed from Mansfield primary, with this proportion forecast to rise to around 44% by 2034 and 45% by 2050). This option also creates the opportunity to split Mansfield BSP between the 11 kV and 33 kV (the possible benefits of which are discussed in the Chesterfield 132 kV report).

Option 5 – Demand transfers

Viable

Capacity released for constraint(s) considered: Demands of Skegby Lane, Teversal and Sutton Junction T3

New limiting factor for constraint(s) considered: As before

Detailed description: The only BSP which Mansfield is interconnected with at 33 kV is Annesley. As there are plans to significantly increase the capacity at Annesley BSP this makes it the prime candidate for permanent load transfers out of Mansfield to deload the GTs.

The three points of interconnection could each provide a possibility for load transfer:

- Sutton Junction T3: as discussed in Section 2.3 of this report T1 and T2 at Sutton Junction are being uprated to 20/40 MVA units, which will facilitate the transfer of Sutton Junction T3 if required (in the long term 33 kV circuit works will also be required, but in the short term this would only require paralleling the site at 11 kV). This transfer would require minimal additional works but would only remove the minimal load at Sutton Junction T3 (around 1 MVA).
- There is a 33 kV circuit interconnecting Huthwaite and Teversal primaries. If a second 33 kV circuit were built (requiring around 3 km of circuit works subject to detailed route investigation and land rights) then Teversal could be transferred into Annesley BSP. This would also necessitate uprating the 33 kV circuits to Huthwaite, but these works are already being triggered as discussed in Section 2.4 of this report. Consideration would need to be given to how this would affect the load balance at Annesley BSP. The demand at Teversal at BSP peak in 2034 is forecast to be around 7 MVA.
- There is a 33 kV circuit from Annesley BSP to Skegby Lane, and another 33 kV circuit from Sutton Junction to Skegby Lane. Both are suitably rated to pick up Skegby Lane, but to provide two infeeds to Skegby Lane the Sutton Junction T3 circuit would need to be repurposed and a third 33 kV circuit built from Annesley BSP to Sutton Junction (requiring around 5.5 km of circuit works subject to detailed route investigation and land rights). Building a dedicated 33 kV circuit directly from Annesley to Skegby Lane is another option to facilitate this transfer, which would require additional circuit works (and an additional 33 kV feeder from Annesley BSP) but would be preferable from a network perspective and would not be reliant on any works at Sutton Junction primary. The demand at Skegby Lane at BSP peak in 2034 is forecast to be around 17 MVA.

Building 33 kV circuits as discussed in two of the transfer options above (Teversal and Skegby Lane) would also increase security of supply for the transferred primary or primaries in the long term as they could be transferred into Annesley/Mansfield BSP for outages on the circuits to the other BSP, maintaining a secure two circuit infeed.

Skegby Lane and Teversal could also each be fed from both Mansfield and Annesley BSPs, however this would create loose couples between the BSPs (unless each primary was run split at 11 kV) and would still necessitate each primary being fed fully from Mansfield BSP for outages on the infeeds from Annesley BSP. This option therefore creates less capacity at Mansfield BSP but does so at a lower cost as new 33 kV circuits would not be required.

Other locations where the Mansfield 33 kV network is in close proximity with the 33 kV networks fed from other BSPs include Acreage Lane being around 2.4 km and 1.4 km respectively from Shirebrook primary (fed from Whitwell BSP) and the 33 kV circuits to Warsop primary (fed from Clipstone BSP), and Lime Tree Place being around 2.3 km from Crown Farm primary (fed from Clipstone BSP). All of these have been ruled out as potential locations for building interconnection and transferring load as the circuits back to the respective BSPs are not suitably rated to pick up the additional load from the aforementioned Mansfield primaries. 11 kV load transfers may be possible but have not been considered as part of this report (and would likely not be of sufficient magnitude to significantly defer reinforcement of the Mansfield BSP regardless).

Option 6 – Review seasonal ratings

Viable

Capacity released for constraint(s) considered: Dependent on review

New limiting factor for constraint(s) considered: As before

Detailed description: Overloads are only seen in 2028 for intermediate cool. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution (as by 2034 overloads are projected for all seasons).

Option 7 – Procure flexibility under Mansfield BSP

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the GTs at Mansfield BSP. The viability of utilising flexibility will be further investigated as part of the DNOA process (but may not be a long term solution due to the high levels of growth seen in the forecasts).

Solution Recommendation

Some combination of reviewing the seasonal ratings, demand transfers and flexibility procurement may be able to defer the reinforcement of Mansfield BSP in the short term. In the case of demand transfers some of the potential transfers would require significant 33 kV circuit works and therefore significant resources/expenditure. The benefits of deferring the reinforcement of Mansfield BSP would therefore need to be weighed against the costs associated with each transfer (new circuits into Annesley BSP could also trigger 33 kV busbar works to create additional feeder bays as well as the circuit costs alone).

In the long term options 2 and 4 (a third 132/33 kV GT and two 132/11 kV GTs respectively) are both viable solutions to resolve the constraint. Two 132/11 kV GTs may be preferable from a network perspective as such a high proportion of the forecast load growth is at Mansfield primary, but both options will be subject to sufficient space being available at Mansfield BSP for new GTs.

2.6 Mansfield primary transformer overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.6.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Mansfield primary transformer overload	Arranged or fault outage on either Mansfield primary transformer	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: This constraint is present in all seasons by 2028 under Best View, so is only further exacerbated under the higher growth scenarios (Leading the Way and Consumer Transformation). Under System Transformation and Falling Short this constraint does not require intervention by 2034.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.6.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers at Mansfield primary.
2	Install additional transformers at Mansfield primary.
3	Install two 132/11 kV GTs at Mansfield BSP.
Flexibility Services	
4	Procure flexibility under Mansfield primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the transformers at Mansfield primary

Discounted

Capacity released for constraint(s) considered: N/A

New limiting factor for constraint(s) considered: As before

Detailed description: Uprating the two 33/11 kV transformers at Mansfield primary would alleviate this constraint. This option is not viable as the transformers are already the highest rating NGED uses on the network as standard. Utilising non-standard equipment creates a number of issues, such as finding replacements if serious faults occur.

Option 2 – Install additional transformers at Mansfield primary

Capacity released for constraint(s) considered: 38 MVA

Viable

New limiting factor for constraint(s) considered: As before

Detailed description: Installing a third primary transformer at Mansfield alone would not create any additional capacity for the 11 kV network, as the transformers would still be fed from only two 33 kV busbars (so for the loss of a busbar two primary transformers could be lost). To create additional primary transformer capacity at Mansfield BSP either a third 33 kV busbar or four primary transformers are required.

If four primary transformers (two existing and two new) were installed then two Mansfield primaries could be created, doubling the capacity for Mansfield 11 kV. If a third 33 kV busbar were installed this would facilitate the future connection of a third GT at Mansfield BSP (as discussed in Section 2.5 of this report). Creating a three transformer primary at Mansfield would carry disadvantages in terms of operability (such as having to split the 11 kV network for an arranged outage on any primary transformer to prepare for a possible subsequent fault). Installing additional primary transformers would require additional 33 kV feeders at Mansfield BSP (this would not be an issue if a new 33 kV busbar were being installed).

Option 3 – Install two 132/11 kV GTs at Mansfield BSP

Capacity released for constraint(s) considered: 38 MVA

Viable

New limiting factor for constraint(s) considered: New 132/11 kV GT capacity

Detailed description: Replacing the existing 33/11 kV primary transformers at Mansfield with two 30/60/78 MVA 132/11 kV GTs would alleviate this constraint and provide enough capacity on the 11 kV network at Mansfield for long term future growth. This option would also alleviate the constraints seen on the 132/33 kV GTs at Mansfield BSP as discussed in Section 2.5 of this report. Installing 132/11/11 kV GTs would however require significant 11 kV works to be carried out, and would present some challenges from an operability standpoint. Another option could be to install 15/30/39 MVA 132/11 kV GTs and retain the existing primary transformers. This would create a similar amount of capacity to 132/11/11 kV units but would not deload the 132/33 kV GTs as much (and would be subject to sufficient space being available at Mansfield BSP).

Another benefit of installing 132/11 kV GTs is that load could be transferred at 11 kV from the nearby primaries fed from Mansfield BSP (namely Skegby Lane and Lime Tree Place, both of which are in close proximity to the BSP). Demand transfers from Skegby Lane could help alleviate the constraint on one of the 33 kV circuits to the primary discussed in Section 2.7 of this report.

Option 4 – Procure flexibility under Mansfield primary

Flexibility service type: Generation turn up/demand turn down.

Viable

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the transformers at Mansfield primary. The viability of utilising flexibility will be further investigated as part of the DNOA process (but may not be a long term solution due to the high levels of growth seen in the forecasts). If installing 132/11 kV GTs was deemed the optimal reinforcement strategy this constraint would need to be managed alongside the constraint on the GTs at Mansfield to defer reinforcement, and both constraints would need to be considered together for a CBA.

Solution Recommendation

Both of the viable reinforcement options for managing this constraint (installing additional primary transformers and installing 132/11 kV GTs) need to be considered together with the reinforcement plans for the GTs at Mansfield BSP as discussed in Section 2.5 of this report. If a third 132/33 kV GT was installed at Mansfield then a third primary transformer would likely be the optimal reinforcement solution, whereas if two 132/11 kV GTs were installed then this would alleviate the constraints on both the primary transformers and GTs.

2.7 Mansfield – Skegby Lane Tee 33 kV circuit overload

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.7.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Mansfield – Skegby Lane Tee 33 kV circuit overload	Arranged or fault outage on the main 1 33 kV busbar at Mansfield BSP	None	-	2034	-	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint occurs for other seasons in 2034 for the higher growth scenarios (Leading the Way and Consumer Transformation).

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.7.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the section of 33 kV circuit to the Skegby Lane Tee.
2	Unstitch Skegby Lane and Teversal primaries.
3	Transfer Skegby Lane or Teversal primary.
4	Move 33 kV feeders at Mansfield BSP.
Flexibility Services	
5	Procure flexibility under Skegby Lane and Teversal primaries.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the section of 33 kV circuit to the Skegby Lane Tee

Viable

Capacity released for constraint(s) considered: Up to 20 MVA

New limiting factor for constraint(s) considered: Other 33 kV infeeds to Skegby Lane and Teversal

Detailed description: By uprating the section of 33 kV circuit between the main 2 busbar at Mansfield BSP and the tee to Skegby Lane primary this constraint would be alleviated. This would require around 3 km of circuit works, and would not require any additional 33 kV feeders at Mansfield BSP.

Option 2 – Unstitch Skegby Lane and Teversal primaries

Viable

Capacity released for constraint(s) considered: Up to 20 MVA

New limiting factor for constraint(s) considered: As before

Detailed description: By building a new 33 kV circuit from Mansfield BSP to the Skegby Lane tee, Skegby Lane and Teversal primaries could be unstitched. This would require around 3 km of circuit works subject to detailed route investigation and land rights and would provide two clean infeeds to each of the primaries, alleviating this constraint. However, this would require an additional 33 kV feeder at Mansfield BSP.

Option 3 – Transfer Skegby Lane or Teversal primary

Viable

Capacity released for constraint(s) considered: Demand of Skegby Lane or Teversal primary

New limiting factor for constraint(s) considered: As before

Detailed description: If either or both of Skegby Lane and Teversal primary were to be fed from Annesley BSP (either partially or fully) under normal running arrangements as discussed as an option in Section 2.5 of this report then this constraint would be alleviated. This would obviate the requirement for intervention on the 33 kV circuit as proposed in options 2 and 3 above.

Option 4 – Move 33 kV feeders at Mansfield BSP

Viable

Capacity released for constraint(s) considered: Dependent on seasonal loadings

New limiting factor for constraint(s) considered: As before

Detailed description: At present as there are only two 33 kV busbars at Mansfield BSP there are no viable options for rearranging the three circuits to Skegby Lane and Teversal (if the circuit to the Skegby Lane tee were moved then this constraint could be alleviated but one or both of Skegby Lane and Teversal would be lost for an arranged or fault outage on a 33 kV busbar at Mansfield).

If however a third 33 kV busbar were installed at Mansfield BSP as discussed in Section 2.5 of this report then the three circuits to Skegby Lane/Teversal could be each secured onto a separate bar. This would alleviate this constraint for a busbar outage, but would leave the constraint for an N-2 on two of the circuits. By restricting outage seasons this constraint could then be mitigated, but this would not be a long term solution (and would reduce network operability).

Option 5 – Procure flexibility under Skegby Lane and Teversal primaries

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured at Skegby Lane and Teversal primaries to alleviate the projected overloads seen on the 33 kV circuit to the Skegby Lane tee. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The solution to this constraint needs to be considered in conjunction with the options considered for the GTs at Mansfield BSP, as the transfer of Skegby Lane and/or Teversal and installing a third 33 kV busbar at Mansfield BSP would both help to alleviate this constraint. If neither of these options were progressed then the optimal reinforcement strategy would be to either uprate the 33 kV circuit to the Skegby Lane tee or unstitch the primaries (unstitching the primaries would be preferable for the long term development of the network but would be dependent on Mansfield BSP accommodating an additional 33 kV feeder, and on the viability of adding a new 33 kV circuit along a similar route to the existing circuit).

2.8 Skegby Lane T1 infeed 33 kV circuit overload

Constraint Overview

Generation Demand

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.8.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed under Best View
			Summer (generation)
Skegby Lane 33 kV infeed to T1 circuit overload	Mansfield – Skegby Lane T2 arranged or fault outage	None	2028

Uncertainty under other Distribution Future Energy Scenarios: This constraint occurs under every scenario in 2028.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.8.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the section of 33 kV circuit to Skegby Lane T1.
Operational Mitigation	
2	Transfer a 33 kV generator into Annesley BSP.
3	Active Network Management.
Flexibility Services	
4	Procure flexibility under Skegby Lane primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution.

Option 1 – Uprate the section of 33 kV circuit to Skegby Lane T1

Discounted

Capacity released for constraint(s) considered: 7 MVA

New limiting factor for constraint(s) considered: Upstream 33 kV circuit to the Skegby Lane tee

Detailed description: Uprating the section of 33 kV circuit to the Skegby Lane main 1 33 kV busbar would alleviate this constraint. This would require just under 3 km of circuit works, and would also increase the demand capacity of Skegby Lane primary (provided the constraint from Mansfield BSP to the Skegby Lane tee were resolved as discussed in Section 2.7 of this report).

This option has been discounted as this expenditure is not justified given the viability of some of the options discussed below.

Option 2 – Transfer a 33 kV generator into Annesley BSP

Viable

Capacity released for constraint(s) considered: Generation output of the 33 kV generator

New limiting factor for constraint(s) considered: As before

Detailed description: This constraint is caused by the generation connected or due to connect to the 11 kV network at Skegby Lane primary exporting at the same time as a 33 kV generator for a fault on the other 33 kV circuit to Skegby Lane. This constraint could therefore be alleviated by transferring the 33 kV generator into Annesley BSP (which would require minimal additional works as there is already a 33 kV circuit from Annesley BSP to the generator).

Option 3 – Active Network Management

Viable

Capacity released for constraint(s) considered: Dependent on curtailment

New limiting factor for constraint(s) considered: As before

Detailed description: Any additional connections at Skegby Lane 11 kV would be included in an Active Network Management (ANM) scheme. ANM schemes are used to manage constraints on over-committed networks.

Option 4 – Procure flexibility under Skegby Lane primary

Discounted

Flexibility service type: Generation turn down/demand turn up.

Detailed description: Flexibility is not suitable to manage this constraint as it is generation driven. Managing generation constraints using flexibility procurement is technically feasible, but NGED’s internal tools and processes for calculating flexibility requirements for generation constraints are still in development.

Solution Recommendation

Active Network Management (ANM) can be used to manage this constraint, meaning reinforcement is not required. The possibility of transferring the 33 kV generator into Annesley either on a temporary or permanent basis could be explored to reduce the curtailment required under ANM.

2.9 Clipstone 33 kV Network Complexity

Constraint Overview

Generation Demand

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.9.1 ends and addresses on the existing network

Constraint	Asset	Making dead		Protection clearance		Isolating	
		Sites	Ends	Sites	Ends	Sites	Ends
Complexity of 33 kV circuit under P18 (existing network)	33 kV circuit from Clipstone to Ollerton primary T1	2	2	5	5	2	2
Complexity of 33 kV circuit under P18 (existing network)	33 kV circuit from Clipstone to Thoresby primary T2	2	2	5	6	2	2

Uncertainty under other Distribution Future Energy Scenarios: This constraint is present in the baseline, and the level of growth seen in each scenario will not affect this constraint as it is a complexity issue.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.9.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Build a new BSP.
2	Install new 33 kV circuits to Ollerton and Thoresby primaries.
Operational Mitigation	
3	Alternative running arrangements.
Other	
4	No intervention.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness. The full CBA has been carried out for this constraint as part of the RIIO-ED2 Business Plan.

Option 1 – Build a new BSP

Discounted

Capacity released for constraint(s) considered: Resolves P18 issue

New limiting factor for constraint(s) considered: As before

Detailed description: A new BSP could be built to pick up some of the primaries currently fed from Clipstone BSP, resolving the P18 issue and adding significant demand and generation capacity to the 33 kV network. The closest 132 kV network which this BSP could be fed from is the 'AX' route between Staythorpe GSP and Checkerhouse BSP. Installing a BSP here has been discounted for a number of reasons. Firstly, a new BSP on these 132 kV circuits would put that network non-compliant with P18 as there are already two BSPs and two 132 kV generators (one on each circuit) fed from this dual circuit. Secondly, this BSP would be significantly underutilised as the demand forecast at Clipstone BSP is not large enough to warrant a new BSP in the short or medium term.

Any other potential BSP location (for example fed from the 132 kV dual circuit to Mansfield and Clipstone BSPs) would require significant circuit works at either 33 kV or 132 kV to pick up the primaries required to resolve this P18 restriction, making it prohibitively expensive. The two other BSPs in close proximity to Clipstone (Annesley and Mansfield) which could benefit from a new BSP are both located the other side of Clipstone to the primaries which would need to be picked up (Ollerton, Thoresby and Bilsthorpe).

Option 2 – Install new 33 kV circuits to Ollerton and Thoresby primaries

Viable

Capacity released for constraint(s) considered: Resolves P18 issue

New limiting factor for constraint(s) considered: As before

Detailed description: 33 kV circuits could be installed from Clipstone BSP to Ollerton and Thoresby primaries (requiring around 9 km of circuit works each subject to detailed route investigation and land rights). This would leave the network with two clean feeds to both Thoresby and Ollerton primaries. One of the new circuits would feed Thoresby T1 and Budby primary, with the other feeding Ollerton T2 and Bilsthorpe T2. This removes all P18 non-compliances on the Clipstone 33 kV network and provides significant additional generation and demand capacity for the primaries discussed and the overall 33 kV network.

Initial assessments concluded that these two 33 kV circuits would need to be 100% underground cable. As Thoresby and Ollerton primaries are located in close proximity to each other (being just over 1 km apart) most of the distance of 33 kV cable could be laid in the same trench at the same time, leading to significantly reduced costs and resources required.

In the first instance a new 33 kV circuit to Ollerton would be sufficient to resolve this complexity issue. The network could then be operated as a 33 kV ring, and additional 33 kV switchgear would be installed at a number of primaries to help alleviate difficulties created by the existing arrangement with regards to protection. While laying the new 33 kV cable from Clipstone to Ollerton, ducting would also be laid in preparation for a new cable to Thoresby (to be installed at a later date as required).

Option 3 – Alternative running arrangements

Discounted

Capacity released for constraint(s) considered: None

New limiting factor for constraint(s) considered: As before

Detailed description: A number of alternative running arrangements were considered to manage this constraint, none of which were deemed viable. The only running arrangements which resolved the P18 restriction on the Clipstone 33 kV network left one or more primary substations at single circuit risk. This was deemed unacceptable as it would reduce the security of supply for a large number of customers and put NGED in breach of Engineering Recommendation P2.

Option 4 – No intervention

Discounted

Capacity released for constraint(s) considered: N/A

New limiting factor for constraint(s) considered: As before

Detailed description: Leaving the 33 kV network as it is would mean no additional generation could connect to the Clipstone 33 kV network, and poses challenges from an operability perspective due to the complexity of the network. Grading the protection on the 33 kV network is also a challenge under the existing arrangement.

Solution Recommendation

Laying two 33 kV cables to Ollerton and Thoresby primaries is the optimal long term reinforcement strategy for resolving this P18 issue (the other solutions discussed are either significantly more expensive in the case of a new BSP or not viable in the case of managing the constraint operationally or taking no action). In the short to medium term the network can be managed with a single new cable laid to Thoresby primary (to allow the network to be operated as a 33 kV ring). This new cable would be laid alongside ducting to facilitate the eventual installation of a circuit to Thoresby as well.

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