Northern Gas Networks

A23.E - NGN RIIO-2

Investment Decision Pack
Reinforcement

we are the network

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2. Introduction

This Engineering Justification paper details our proposals for investment on Reinforcement during RIIO-2. It explicitly follows Ofgem's guidance and is set out in accordance with the headings therein. There is no accompanying Cost Benefit Analysis as the workload is Third Party driven.

We have obligations under the Gas Act and our Gas Transporters licence to ensure we can supply our customers in a winter of 1 in 20 severity and demand growth may mean we have to reinforce our network to ensure we comply with these conditions.

This engineering paper aims to outline the justification for our proposed RIIO-2 Reinforcement investment for both General and Specific. It explains the different options we have considered and the reasons why we have derived at our forecasts.

3. Equipment Summary

Local Transmission System – approximately 1,300km of high-pressure pipelines (greater than 7 bar) which are used to transport volumes of gas over long distances around our network. The pipelines connect Nation Transmission System (NTS) Offtakes, Pressure Reduction Stations and Governors and feed the intermediate, medium and low-pressure networks. Our high-pressure pipelines are considered to have enough capacity to meet current and future demand and so we have not included for any LTS reinforcement in RIIO-2.

Distribution Network – 265 networks consisting of approximately 35,000km of mains and over 2.5 million services which provide gas to domestic, commercial and industrial consumers. The distribution network is operated at < 7 bar and can be split into three pressure tiers: intermediate, medium and low pressure. This predominantly below ground network is constructed from a variety of materials: pit-cast iron, spun-cast iron, ductile iron, steel and polyethylene.

District Governors – A pressure regulating system operating with an inlet below 7 bar supplying the intermediate, medium or low-pressure networks with more than ten customers.

1:20 – The 1:20 peak 6-minute demand is defined as the maximum demand that will occur, on average, in not more than 1 winter out of 20 years. This is defined as an average in any period of 6 minutes, expressed as an hourly rate - standard cubic metres per hour (scmh).

General Reinforcement – General reinforcement is usually identified following either a Model Validation or the annual Demand Derivation System (DDS) demand refresh. Both processes give our modelling capabilities a sound footing for analysis and design of new connections and network changes.

Network Validation is a process to establish confidence in a graphical network model by comparing the model to the actual characteristics of a network and is used for the purpose of predicting pressures. The benefit of validation is that the network analysis model can be used to support decision making regarding holistic network development as required by NGN/PL/NP18 'Policy for Network Planning', together with the management of source pressures and operational activities affecting gas supplies.

The DDS demand refresh takes place annually during June and is the process of updating individual demands within the network analysis models. It follows an annual update from Xoserve.

If, once the network analysis model has been validated or updated, any pressures within the model are simulated to fall below the minimum design pressure, a general reinforcement will be identified to rectify those pressure issues. These reinforcements are fully funded by us and will not be subject to an Economic Test.

Specific Reinforcement – Specific reinforcement is customer driven in that it is required when a new customer wishes to connect to our network or when a customer is wanting to increase their existing load. When a customer wishes to connect, they contact the Connections team, who will run network analysis to ascertain whether the network has the available capacity to accept the new connection. New connections can range between one single domestic property, a full housing development, a new factory, a commercial office building or a power generation plant. These are all analysed on an individual basis.

The Connections and Large Loads teams will establish if reinforcement is required to be able to accept the new demand on our network and will establish a Charging Point for the reinforcement.

The Charging Point is the closest economically feasible point (considering any customer request for gas to be made available at a particular pressure) on our system, which is deemed to have enough capacity to supply the new load disregarding existing loads. It is identified by network analysis and if the network minimum design pressure can be maintained at the connection point with the new connecting customers load applied, this will be the Charging Point. If the new load cannot be supported to maintain at least the network minimum design, or minimum supply pressure in accordance with GRM requirements, then the load should be retested at points upstream, until the load can be supported with all other demands removed, this will then become the Charging Point.

The Economic Test determines the maximum economic investment we can make in respect of a specific annual load, and where appropriate daily and hourly loads. The test compares the anticipated transportation charges with the incremental costs of the new load. Where the criteria of the Economic Test are not met, we require a connecting party to pay a contribution towards the cost of the reinforcement in order to avoid our existing customers subsidising a new load. However, if a new connection passes the Economic Test, reinforcement costs are not recovered from the connecting party. In most instances the results of the Economic Test mean that no costs are recovered from our customers for reinforcement.

4. Problem Statement

Why are we doing this work and what happens if we do nothing?

Under the Gas Act we are obliged to develop and maintain an efficient and economical pipeline system for the conveyance of gas and to comply with any reasonable request to connect to our system any premises or any pipeline system operated by an authorised transporter.

Our customers appliances require 14.25mbar in their appliances to allow them to operate safely. We need to allow for pressure loss down service pipes and a customer’s ECV and meter which means that we must provide a minimum of 21mbar in our low-pressure mains. If the network analysis models predict that these minimum pressures will not be met in a 1:20 winter, reinforcement of the network will be required to ensure security of supply for our customers.

Reinforcement is driven by demand growth which we analyse and design in our network analysis models in Synergi Gas System. Reinforcement is carried out when the Synergi Gas network analysis models predict that one of the following will occur in a 1:20 winter:

- Pressures will drop below design minimum pressures following network Validation or addition of a new connection or increase of existing connection.
- CSEP (Connected System Exit Point) pressures will drop below their contracted pressures.
- District Governors are showing signs of going out of capacity.

If we do not reinforce the network, capacity for new connections may not be available. Security of supply could be compromised, ultimately resulting in loss of gas to customers. For non-domestic customers, this could also result in loss of income. Negative implications of this may be: negative publicity, reduced confidence from our regulator and customers, breaching licence obligations, GSOS payments and safety concerns to the public and our workforce.

What is the outcome that we want to achieve?

We want to ensure that any customer who wants to connect to our network can and that existing customers do not suffer from poor pressures or a supply interruption. In addition to this we want to deliver our connections service and reinforcement projects in the most safe and efficient way possible, managing pressures with operational solutions before installing new mains, meeting our customers' expectations in terms of time scales and minimising disruption to the public and our stakeholders.

Our reinforcement process is carried out in three stages to ensure that we meet our objectives:

Stage 1 – categorise the scheme

There are 3 categories of reinforcements:

Category A reinforcements are schemes where increasing pressures as a contingency is not an option (i.e. the pressure would have to be increased beyond the District Governor's capacity or above the maximum operating pressure (MOP) for the pressure tier). Category A reinforcements are pipelaying schemes, they are progressed for approval and completed at Stage 1.

Category B reinforcements are schemes where a pressure increase is an option, but the pressure needs to be higher than the MOP of the District Governor (the maximum source pressures which should not be exceeded without the consent of the Responsible Engineer appointed by the Network Director). Category B reinforcement schemes are put through Stage 2.

Category C reinforcements are schemes where a pressure increase is a viable option and the pressure is lower than that MOP of the District Governor. Category C reinforcement schemes are pressure increases. These are progressed for approval via the NP37 process and are completed at Stage 1.

Stage 2 – assess the pressure increase

For all Category B reinforcements, a contingency pressure increase option is reviewed against a risk matrix that was developed in 2016 following discussions between the Pressure Management, Validation, and Connections team representatives. The matrix balances several network factors including the type of pressure management existing in the relevant subsystem, the percentage pressure increase required and the length and percentage of metallic mains in relevant subsystem. Dependent on the output from the matrix, the project could either be progressed under an NP37 pressure increase request (as per Category C) or given further consideration in Stage 3.

Stage 3 – Cost Benefit Analysis (CBA)

This stage compares the differences between the average system pressure in the relevant subsystem with the proposed reinforcement in place, to the average system pressure with the contingency pressure increase in place. Synergi software is used to calculate the Average System Pressures (ASP's) which feed into the National Leakage Reduction Model to calculate the difference in shrinkage / leakage. The cost of the increase in shrinkage / leakage is compared to the cost of the project and a payback period calculated. Dependent on the output from this CBA, the reinforcement could either be progressed as an NP37 pressure increase request (as per Category C above) or the pipe scheme progressed for approval and construction. A payback period of 16yrs has been used:

- If payback <=16yrs progress for approval to construct
- If payback >16yrs progress under an NP37 pressure increase request

Benefits of the three-stage process

The three-stage process ensures we carry out the most efficient and cost-effective reinforcement scheme in order to maintain minimum design pressures within the network. Last regulatory year alone (2018/19), the three-stage process saved approximately £3.5million. The figures for 2019/20, to date, show that we have saved approximately £4.5million.

If we can increase District Governor pressures in the area instead of pipe reinforcements this will benefit our customers and the general public as there will be less disruption on the roads and pavements. In addition, it means that customers can connect sooner to our network as they don't have to wait for the reinforcement scheme to be authorised and constructed.

If a contingency pressure is not available or a design is required, extensive analysis of the network is carried out by skilled analysts to identify the most effective, best value for money scheme for our customers. Whilst evaluating potential schemes, the analyst must take into consideration the following:

- least disruption to our customers
- assess environmental impact
- avoid areas with S58 restrictions or environment agency restrictions
- constructability – is the scheme viable?
- reinstatement implications
- optimum route, i.e. avoid geographic obstructions, major roads, waterways
- abandon metallic mains where practicable
- hybrid schemes (minor pressure increase alongside a small pipe lay scheme)
- multiple options designed and considered
- holistic approach to network reinforcement

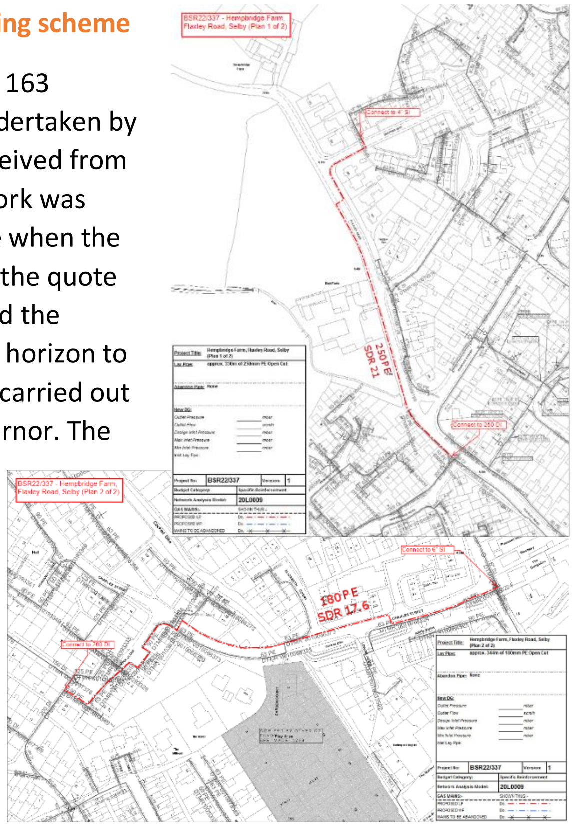
How will we understand if the spend has been successful?

There are several ways in which we track our performance in this area:

- Delivery of the project within the required timescales to allow the customer to connect and have their contracted pressure available to them
- No poor pressure reports following reinforcement completion
- No PRE's reported following reinforcement completion

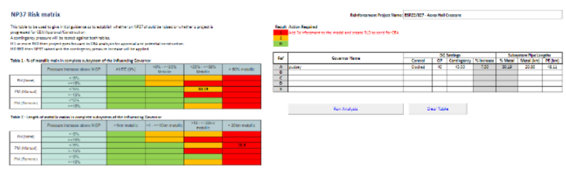
4.1. Narrative Real-Life Example of Problem

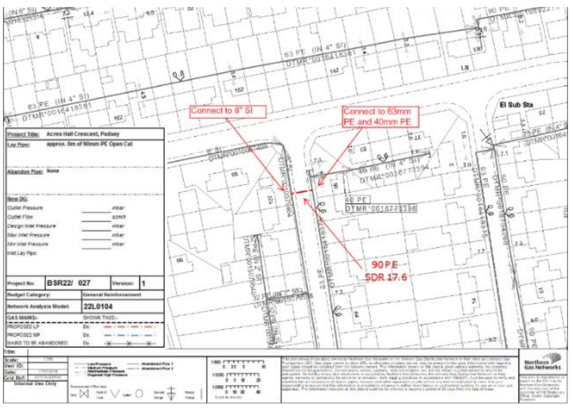
Case Study 1 – Category A Reinforcement – pipe laying scheme



A Specific Reinforcement due to a new connection of 163 dwellings in the Selby area. Network Analysis was undertaken by the Connections team when the enquiry was first received from the customer and the analysis showed that the network was simulated to fall below the minimum design pressure when the new load was added to the model. On acceptance of the quote by the customer the load was added to the model and the Validation team re-analysed the new load at a 5-year horizon to identify a reinforcement scheme. A supply trace was carried out on the model to identify the influencing District Governor. The pressure at the District Governor was increased to find the contingency pressure. The pressure at the District Governor had to be increased past 75mbar (the maximum operating pressure for the LP tier), thus making it a Category A reinforcement – a pipelaying scheme. A scheme was identified, designed, costed, approved and issued for construction.

Case Study 2 – Category B Reinforcement – pipe laying scheme

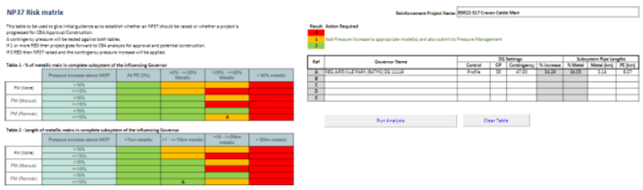


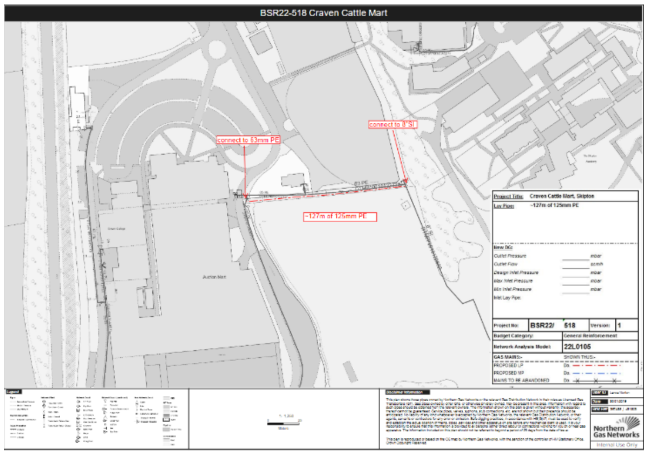


A General Reinforcement following the validation of the Wharfe Valley low-pressure network analysis model. The Validation team carried out a supply trace on the model to identify the influencing District Governor. The pressure at the District Governor was increased to find the contingency pressure. The contingency pressure was below the maximum operating pressure for the low-pressure tier but above the maximum operating pressure of the governor, thus making it a Category B reinforcement. The pipe material mix of the Zone of Influence for the governor was input into the

NP37 matrix and the outcome was one Amber and one Red result. The appearance of a Red result meant that a pipe lay scheme had to be identified, designed, costed and subjected to a Cost Benefit Analysis which showed that a pipelaying scheme was the best solution and was issued for construction.

Case Study 3 – Category B Reinforcement – pressure increase



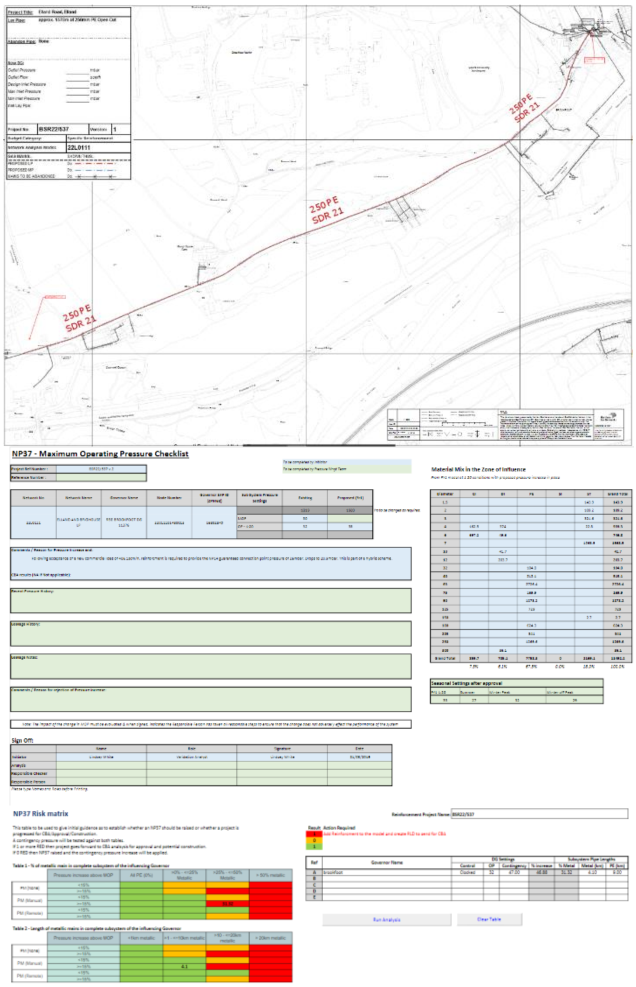


A General Reinforcement following reports of poor pressures within the Aireville Park area of Skipton. The Validation team carried out a supply trace on the model to identify the influencing District Governor. The pressure at the District Governor was increased to find the contingency pressure. The contingency pressure was below the maximum operating pressure for the low-pressure tier but above the maximum operating pressure of the governor, thus making it a Category B reinforcement. The pipe material mix of the Zone of Influence for the District Governor was input into the NP37 matrix and the outcome was one Amber and one Green result. A NP37 request was issued to Leakage Control. It was decided that the pressure increase was too substantial therefore a Cost Benefit Analysis was requested. A pipe lay scheme was identified, designed, costed and subjected to a CBA which showed that a pressure increase was the best solution. This was fed back to Leakage Control and the NP37 was authorised and a pressure increase actioned.

Case Study 4 – Category C Reinforcement – pressure increase

A Specific Reinforcement due to a new connection of 3scm/h multiple domestic load in the Selby area. Network Analysis was undertaken by the Connections team when the enquiry was first received from the customer and the analysis showed that the network was simulated to fall below the minimum design pressure when the new load was added to the model. On acceptance of the quote by the customer the load was added to the model as an accepted load and the Validation team re-analysed the new load at a 5-year horizon to identify a reinforcement scheme. A supply trace was carried out on the model to identify the influencing District Governor. The pressure at the governor was increased to find the contingency pressure. The contingency pressure was below the maximum operating pressure of the governor thus making it a Category C reinforcement. An NP37 request was issued to Leakage Control. The NP37 was authorised and a pressure increase actioned.

Case Study 5 – Category B Reinforcement – pipe abandonment scheme A Specific Reinforcement due to a new connection of 406scm/h commercial load in the Elland area. Network Analysis was undertaken by the Connections team when the enquiry was first received from the customer and the analysis showed that the network was simulated to fall below the minimum design pressure when the new load was added to the model. On acceptance of the quote by the customer the load was added to the model as an accepted load and the Validation team re-analysed the new load at a 5-year horizon to identify a reinforcement scheme. A supply trace was carried out on the model to identify the influencing District Governor. The pressure at the governor was increased to find the contingency pressure. The contingency pressure was below the maximum operating pressure for the low-pressure tier but above the maximum operating pressure of the governor, thus making it a Category B reinforcement. The pipe material mix of the Zone of Influence for the District Governor was input into the NP37 matrix and the outcome was one Green and one Red result. The appearance of a Red result meant that a pipe lay scheme had to be identified, designed, costed and subjected to a Cost Benefit Analysis which showed that a pressure increase was the best solution. A NP37 request was issued to Leakage Control. The pressure increase was too substantial for a mixed material network, therefore an alternative scheme needed to be identified. The alternative scheme was to disconnect a section of the network to isolate the area so that a smaller pressure increase could go ahead resulting in less leakage. The amended NP37 was issued to Leakage Control and the pipe abandonment scheme was issued for construction.



4.2. Spend Boundaries

Costs included within this Engineering Justification Paper are:

- Pipeline reinforcements - the spend will only apply to pipe materials / labour / traffic management / enabling / plant / reinstatement / purge & relights / special ops / legal costs.
- District Governor capacity reinforcements - the spend will apply to design / construction / commissioning / pipe materials (inlet and outlet) / labour / traffic management / enabling / plant / reinstatement / purge & relights / special ops / legal costs.

Costs excluded within this Engineering Justification Paper are:

- Type of work – upsizing due to global models, capacity upgrades at offtakes and PRS's
- Costs – exclude elements paid for by the customer

- Network analysis design work, CBA analysis, commercial costing time, SPM's
- NP37 survey work, additional leakage costs, Pressure Management costs, maintenance costs
- District Governor capacity upgrades (expenditure is justified in the Governor Investment Decision Pack Appendix A23.H)

5. Probability of Failure

This section is left blank as there is no requirement for a Cost Benefit Analysis for Third Party driven workload.

6. Consequence of Failure

This section is left blank as there is no requirement for a Cost Benefit Analysis for Third Party driven workload.

7. Options Considered

Types of Intervention

There are various ways in which we can manage increased demand on our network. Options that are available to us include:

- Increase pressures
- Install remote pressure management to increase pressures
- Install new mains
- Join two networks by installing mains
- Install new District Governor
- Upgrade existing District Governor (stream change)
- Separate networks by install valves
- Offer alternative connection points to customers
- Offer interruptible or seasonal contracts

7.1. Option Summaries

We have developed three options for our RIIO-2 mains reinforcement workload forecast. The options are considered for both General and Specific Reinforcements, they look at historical trends, forward looking growth trends, economic forecasts, RIIO-1 averages & Local Authority plans.

- Option 1 - trends over two price control periods

- Option 2 - trends over RIIO-1 only
- Option 3 - averages over RIIO-1 only

We have developed two options for our RIIO-2 governor reinforcement workload forecast, focussing on historical trends.

- Option 1 - trends over RIIO-1 only
- Option 2 - averages over RIIO-1 only

We have developed two unit cost options for both mains and District Governor reinforcements.

- Option 1 - unit costs are split by type (General and Specific) and pipe diameter (above & below 180mm)
- Option 2 - unit costs are split by pipe diameter only (above & below 180mm).

Future Energy Pathways

We have gone with the default assumption of current assumed proportion of methane CO2 in natural gas projected forwards due to uncertainties in the potential energy pathways and because this is reflective of the current gas quality legislation. However, we acknowledge that significant changes to gas demand or the allowed methane content of gas, for example due to the blending with or conversion to hydrogen, would impact the reinforcement workloads delivered in RIIO-2.

Arup conducted analysis on the potential benefits of our H21 Programme (see A13 - NGN RIIO-2 Consumer Value Proposition) that showed 45% of the gas in our network is expected to be Natural, 15% biomethane and the remaining 40% hydrogen by 2040; due to a combination of blending and sub-areas of our networks being fully converted. This is consistent with Net-zero by 2050 aligned with the ENA Navigant report.

We have not explicitly developed different reinforcement forecasts for changes in the methane content of gas, as overall gas demand and the change in C02 content of the gas is not expected to be different enough during RIIO-2 to materially impact our preferred investment programme. Our strategy therefore represents a no regrets investment programme that is consistent with net zero and will deliver value to customers whether a hydrogen or electrification pathway is chosen.

7.2. Options Technical Summary Table

This section is left blank, see section 8.2 for Option workload comparison.

7.3. Option Cost Summary Table

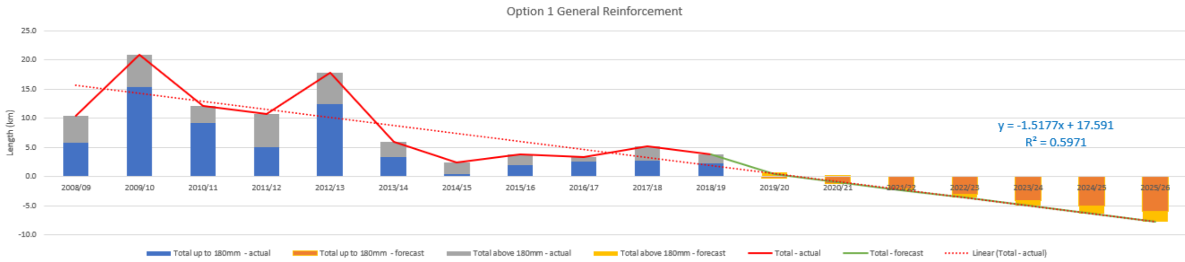
This section is left blank, see section 8.1 for Option unit cost comparison.

8. Business Case Outline and Discussion

8.1. Key Business Case Drivers Description

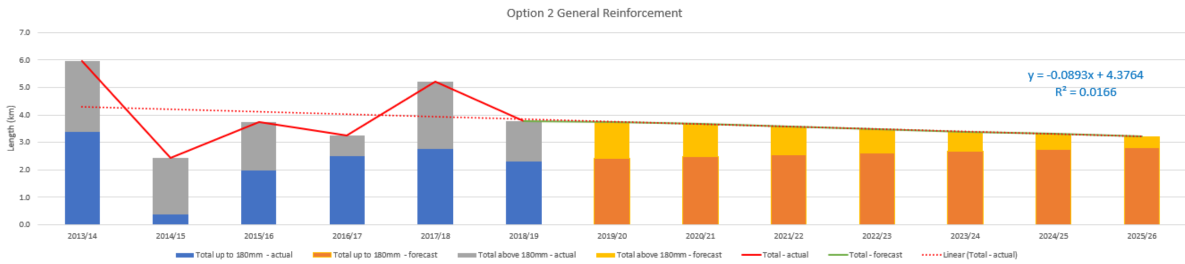
a) General Reinforcement Workload Option Analysis

General Reinforcement Option 1 - This option analyses historic trends using 11 years of data.



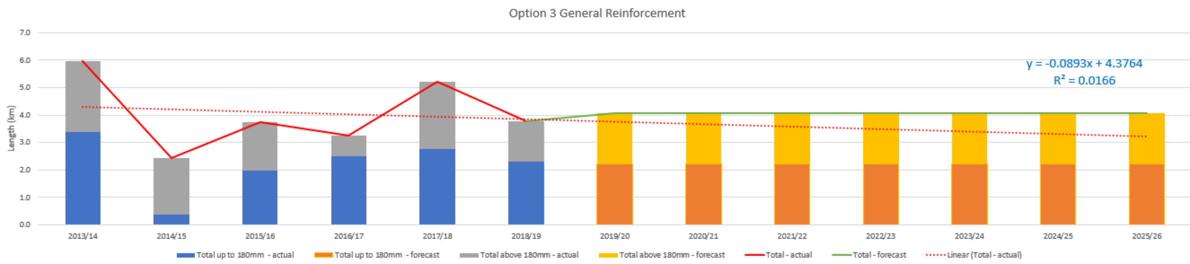
This option forecasts a negative trend line below zero which provides an unrealistic result. This is due to high levels of reinforcement incurred during GDPCR1. Due to the improvements we have made in our decision making during RIIO-1 where we aim for the most cost-effective solution such as increasing pressures or joining two networks our reinforcement costs have reduced significantly leading to the steep declining trend line. This option has been discounted due to the negative results.

General Reinforcement Option 2 – This option analyses historic trends using 6 years of data.



This option forecasts an upward trend line for up to 180mm diameter mains and a downward trend line for above 180mm diameter mains. Overall the total lengths trend down very slightly giving a total length of reinforcement in RIIO-2 of c.17km. This option considers a more uniform dataset during which time we have been undertaking a consistent approach to how we manage reinforcement projects. This option therefore is a good option to consider. This option falls in line with the economic trends and the predicted continuation of growth in housing sector.

General Reinforcement Option 3 – This option analyses average lengths of reinforcement using 6 years of data.



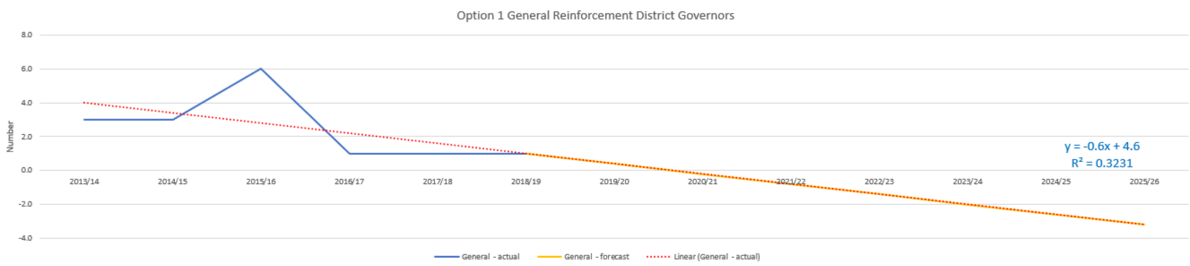
This option forecasts a flat average length of mains over RIIO-2 and does not follow the trend over this period. The averages for above and below 180mm diameter mains are slightly increased compared to the trend and forecast an additional c.3km of reinforcement over RIIO-2 compared to Option 2. There will come a point where we are unable to continue to increase pressures in lieu of reinforcement as we have reached the maximum pressures possible within the low pressure network. As this option holds reinforcement lengths to the averages seen in RIIO-1 this is a good option to consider if we think this point may come during RIIO-2 due to the slight increase in reinforcement lengths compared to Option 2 which forecasts a falling trend.

Conclusion

Option 1 is discounted due to being negative. Option 2 and Option 3 are similar with only a difference of c.3km between them over the RIIO-2 period. Either option could be considered a reasonable approach to forecasting general reinforcement however as reinforcement is driven by demand growth on our network it is more appropriate to use trends where possible as they provide a good indication of what the future might hold. It is important to note however, we cannot continue to raise NP37 requests to increase pressure across the network indefinitely, there will be a point where the network pressure cannot be raised any higher due to leakage concerns or District Governors reaching their limits. When this happens there will be little alternative to pipeline reinforcement resulting in levels of reinforcement more in line with GDPCR1. Until this time though we can use recent historic trends to forecast the future and therefore our preferred option is Option 2. This is also the lower volume of the two feasible options which is a more conservative approach that will benefit our customers.

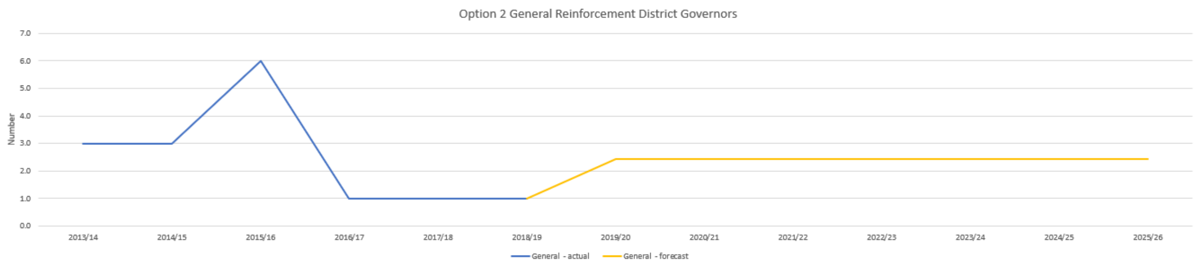
b) General Reinforcement District Governor Workload Option Analysis

General Reinforcement District Governors Option 1 – This option analyses historic trends using 6 years of data.



This option forecasts a negative trend line below zero which provides an unrealistic result. This is due to the small number of District Governors installed each year and spikes in the data causing a steep declining trendline. This option has been discounted due to the negative results.

General Reinforcement District Governors Option 2 – This option analyses average numbers of District Governors installed using 6 years of data.



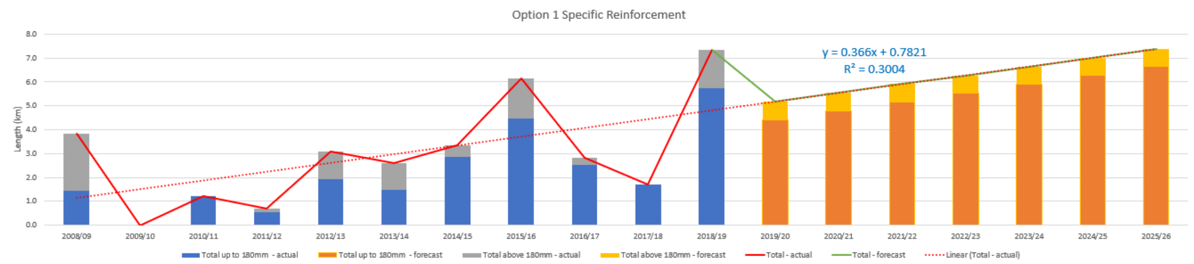
This option forecasts the average number of District Governors installed each year in RIIO-1. This produces a forecast in RIIO-2 of 12 District Governors and seems a sensible approach considering the variation and generally low numbers seen each year in RIIO-1.

Conclusion

Option 1 has been discounted due to the negative forecast produced. Therefore, our preferred option is Option 2.

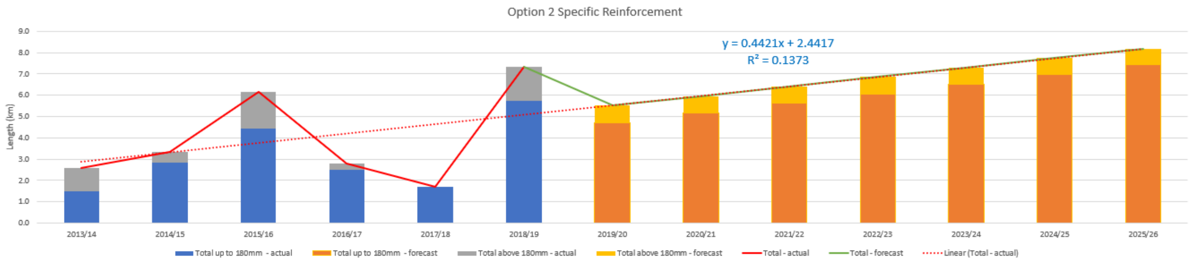
c) Specific Reinforcement Workload Option Analysis

Specific Reinforcement Option 1 – This option analyses historic trends using 11 years of data.



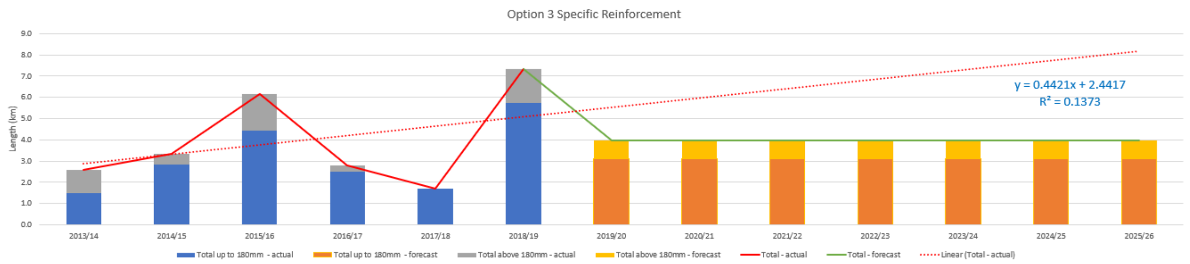
This option forecasts increasing reinforcement across RIIO-2 however we see a relatively flat trend for the larger diameter mains giving a total length of reinforcement in RIIO-2 of c.33km. The increasing trends seen in this option is expected considering the close link between specific reinforcement, the housing market and the economy, which have been steadily improving following the economic crash of 2007/08. However, the first year in this data set, 2008/09 will include for reinforcement projects that were agreed in the years prior to the UK financial crisis hence the large lengths seen when compared to the following three years. This one data point flattens the trend line thus masking the true increasing rate of specific reinforcement projects we have been seeing over the last ten years which would have otherwise resulted in c.40km of reinforcement in RIIO-2 if this outlier was removed. We have analysed our Local Authority development plans and been in dialogue with the larger councils who substantiate the continuing investment in housing and industrial and commercial developments in our region during RIIO-2 so there is no reason why this trend should change.

Specific Reinforcement Option 2 – This option analyses historic trends using 6 years of data.



Much like Option 1 this shows an overall increasing trend with the larger diameter mains remaining relatively flat over RIIO-2. The total length of mains over RIIO-2 is c.2km higher than the previous option at c.35km. This too is a good option to consider. This option falls in line with the economic trends and the predicted continuation of growth in the housing sector. We know of two specific reinforcement projects due in the final two years of RIIO-1, Penrith and Sherburn, which together will equate to over c.11km of reinforcement mains. The chart below includes a forecast of the last two years of RIIO-1 considering these two known projects.

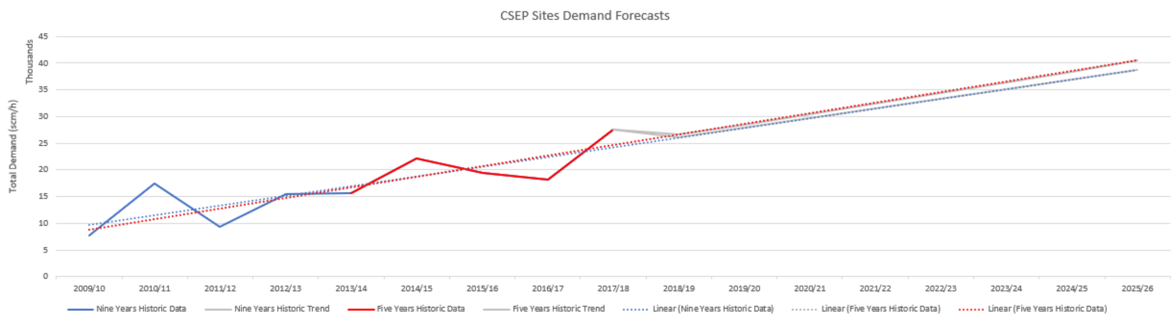
Specific Reinforcement Option 3 – This option analyses average lengths of reinforcement using 6 years of data.



This option delivers a flat profile across RIIO-2 and ignores the historic trends. Overall the option forecasts c.20km of reinforcement which is a c.60% reduction compared to the first option.

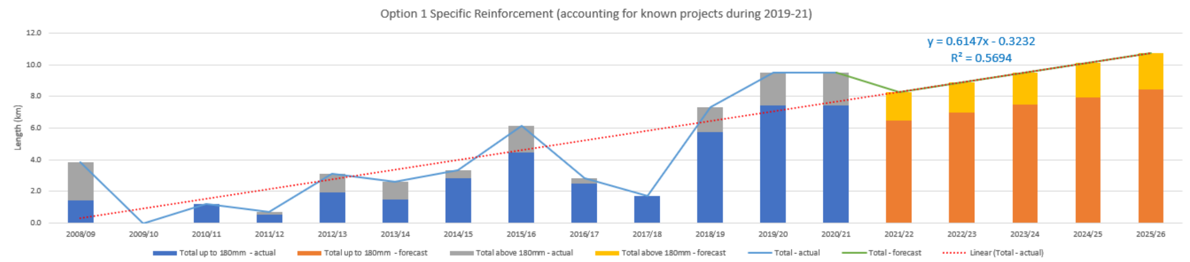
Conclusion

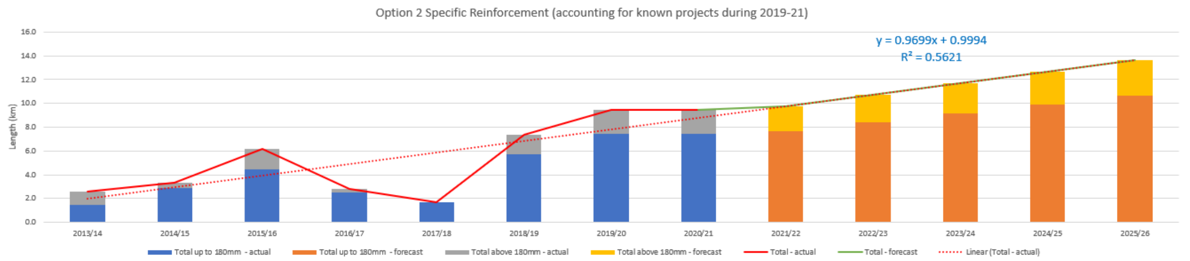
Option 3 is discounted as specific reinforcement is directly driven by housing and economic growth in our region and using averages does not consider the recent upward trends we are experiencing. This leads to the lowest forecast of mains reinforcement of all three options. To further substantiate these trends, the graph below shows the gas demand from CSEP sites over the last nine years and plots trend lines using either nine or the most recent five years of historic data. Trends in CSEP sites are important as they consist of c.90% of all new connections and account for a considerable amount of new gas demand therefore directly contributing to specific reinforcement requirements. Both trend lines on the graph tell a similar story, that gas demand from new connections are increasing which aligns with what we are seeing in terms of the lengths of specific reinforcement.



For further information on our Connection forecasts and our housing growth assumptions see Appendix A23.D - NGN RIIO-2 Investment Decision Pack – Connections.

As reinforcement is driven by demand, timing of projects can have a significant impact on trends and averages. We know of two specific reinforcement projects due in the final two years of RIIO-1, Penrith and Sherburn, which together will equate to over c.11km of reinforcement mains. If we analyse the trend lines considering the final two years of RIIO-1 the result is either c.48km or c.58km of mains reinforcement depending on if you look at an eleven- or six-year historic trend line. These results are shown in the two graphs below.

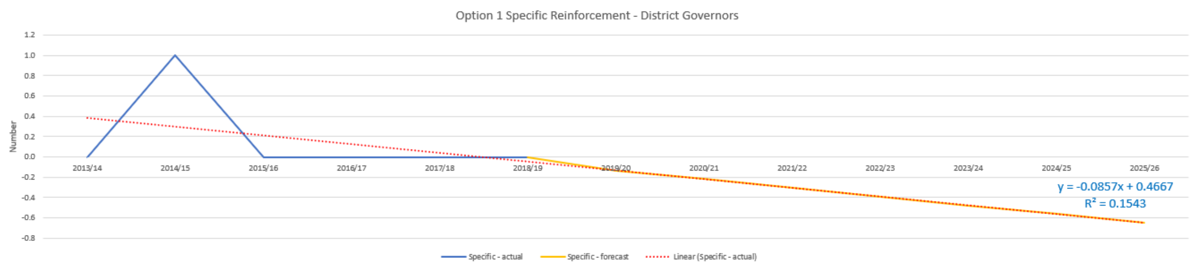




Option 1 and Option 2 take account of recent trends and forecast similar lengths of reinforcement with only a difference of c.3km over the RIIO-2 period. Our preferred option is Option 2 as a shorter historic period considers the more recent changes in the way we manage pressures on our network and will be more representative of how the housing market and the economy are behaving. Considering this option is much lower than forecasts using the two known projects in the final years of RIIO-1, this forecast looks to be on the conservative side and good value for our customers.

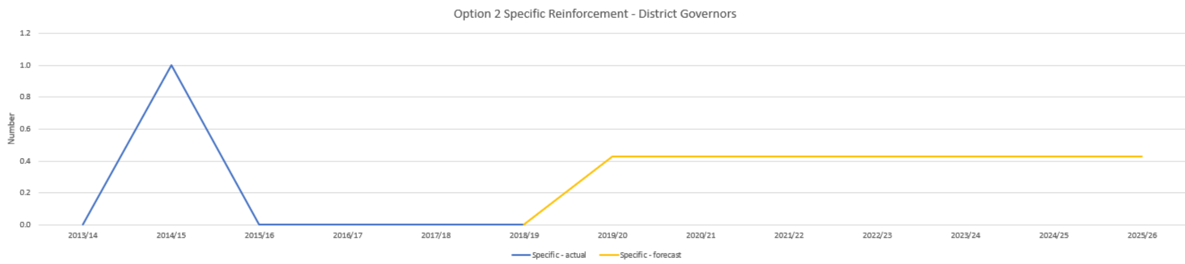
d) Specific Reinforcement District Governor Workload Option Analysis

Specific Reinforcement District Governors Option 1 – This option analyses historic trends using 6 years of data.



This option forecasts a negative trend line below zero which provides an unrealistic result. This is due to the small number of District Governors installed each year and spikes in the early years causing a steep declining trendline. This option has been discounted due to the negative results.

Specific Reinforcement District Governors Option 2 – This option analyses average numbers of District Governors installed using 6 years of data.



This option forecasts the average number of District Governors installed each year in RIIO-1. This produces a forecast in RIIO-2 of two District Governors and seems a sensible approach considering the variation and generally low numbers seen each year in RIIO-1.

Conclusion

Option 1 has been discounted due to the negative forecast produced. Therefore, our preferred option is Option 2.

e) Unit Cost Option Analysis

Mains Option 1 – This option analyses the unit costs for mains delivered during RIIO-1 split by both reinforcement type and diameter. There is a considerable difference in the unit cost of the smaller diameter mains between general and specific reinforcement which does not seem logical and could be down to other project factors unrelated to the type of reinforcement. In addition, for general reinforcement the unit cost for smaller diameter mains is higher than the unit cost for the larger diameter mains which again does not follow what we would expect. For these reasons this option should be discounted.

Mains Unit Costs (£m/km)	Option 1
General <=180mm	£0.517
General >180mm	£0.326
Specific <=180mm	£0.244
Specific >180mm	£0.348

Mains Option 2 – This option analyses the unit costs for mains delivered during RIIO-1 for mains split by diameter but not by type of reinforcement. This provides a more sensible logic where the unit costs are differentiated by the cost driver of diameter and the smaller diameter mains cost less than the larger diameter mains, which aligns with an increase in material and construction cost for larger diameter mains.

Mains Unit Costs (£m/km)	Option 2
General <=180mm	£0.325
General >180mm	£0.333
Specific <=180mm	£0.325
Specific >180mm	£0.333

Reinforcement Governors Option 1 – This option analyses the unit costs for reinforcement District Governors installed during RIIO-1 split by reinforcement type. There are only three data points for specific reinforcement which does not give confidence in a robust unit cost. These unit costs can cover both a new District Governor or a stream change within an existing asset. This will drive significant changes in unit cost like we see here. By splitting up the unit costs by the two types of reinforcement, we would be only allowing for refurbishment costs in RIIO-2 for Specific Reinforcement which would not cover the cost of a new asset if required.

Reinforcement Governors Unit Costs (£m)	Option 1
General Reinforcement	£0.063
Specific Reinforcement	£0.006

Reinforcement Governors Option 2 – This option analyses the unit costs for District Governors installed during RIIO-1 but does not differentiate between the two types of reinforcement. This option provides more data points covering both replacements and refurbishments and provides a single unit cost. The increased data points install more confidence in its accuracy.

Reinforcement Governors Unit Costs (£m)	Option 2
General Reinforcement	£0.054
Specific Reinforcement	£0.054

Conclusion

From the two options analysed for both mains and District Governors, it is Option 2 in both cases which provides a more reasonable and logical unit cost. A single unit cost for mains split by diameter and a single unit cost for District Governors allows the maximum number of data points to be utilised to derive the most accurate average cost. We propose that these unit costs are used to derive our reinforcement costs in RIIO-2.

e) District Governor Capacity Option Analysis

NGN/PL/NP18 & IGEM TD/13 state that the working stream must have capacity to supply forecast gas flow at 1:20 at forecast inlet pressure. The consequence of incorrectly calculated capacities can ultimately be loss of supply to customers. In addition, our governors that are running over capacity will mean that urgent or routine maintenance activities cannot be complete over peak times as both streams will be working, and it can also mean that governors are overutilized and deteriorate quicker.

In 2018 a major exercise was carried out to improve Governor Capacity Asset data held within the Synergi modelling software, this data has been used to accurately calculate governor capacities. We identified 189 District Governors over 100% capacity. Following investigation of each to check that there are no errors with the data and that the pressures in the area are accurate, this list reduced to 98 which equates to about 4% of the asset population. We developed a risk ranking methodology to target the assets based on the numbers of customers we could lose if the governor failed and produced a programme of works covering RIIO-1 and RIIO-2. The results are shown in the table below.

Intervention	Total no. of DG's	Ave. no. of DG's per year
Upgrade in RIIO-1	30	15
Upgrade in RIIO-2	68	14
Total	**98**	-

When deciding on the most cost-effective solution for our customers we analyse different approaches to solving the capacity problem, these include:

- Monitor only (as failure does not lead to a loss of supply)
- Trimming the governor pressure
- Mains reinforcement (incl. joining two networks)
- Refurb the governor (streams swap)
- Replace the governor (existing site)
- Replace the governor (new site)

This process identified the following results:

Intervention	No. of DG's (RIIO-1)	No. of DG's (RIIO-2)	**Total no. of DG's**
Monitor	10	0	**10**
Trim Pressure	3	5	**8**
Mains Reinforcement	0	1	**1**
Governor Refubishment	5	31	**36**
Governor Replacement (existing site)	5	13	**18**
Governor Replacement (new site)	7	18	**25**
Total	**30**	**68**	**98**

We have used unit costs in accordance with our Replacement Governor strategy apart for the mains reinforcement unit cost which has been individually costed. The unit costs used are shown in the table below.

Intervention	No. of DG's (RIIO-2)	Unit Cost (£m)	**Total Cost (£m)**
Monitor	0	£0.00	**£0.00**
Trim Pressure	5	£0.00	**£0.00**
Mains Reinforcement	1	£0.06	**£0.06**
Governor Refubishment	31	£0.02	**£0.48**
Governor Replacement (existing site)	13	£0.09	**£1.23**
Governor Replacement (new site)	18	£0.13	**£2.27**
Total	**68**	-	**£4.04**

The workloads and costs for upgrading these governors have been justified within the Governor Investment Decision Pack A23.H. This has allowed us to undertake option analysis to determine the best solution for our customers and we have used our Decision Support Software, the NARMs methodology and Ofgem's Cost Benefit Analysis template to assess the benefits of each option and choose the most appropriate RIIO-2 workload.

f) Peaking Plant Specific Reinforcement Option Analysis

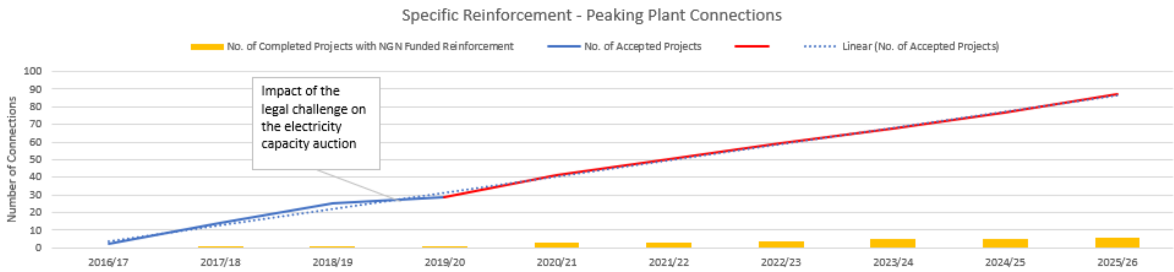
The UK's Capacity Market scheme is designed to ensure there is always enough supply to meet peak electricity demand, especially through the winter months. The scheme provides contracts to firms that offer to supply electricity generating capacity, or turn down electricity demand, during periods of peak demand. This scheme has led to a rise in small scale power generation plants, otherwise known as peaking plants, that can provide flexible power generation with fast ramp up times using gas fired turbines. Peaking plants are playing an increasingly important role in balancing the UK's power requirements and provide extra resilience and capacity when alternative renewable energy sources are not producing enough electricity.

The uptake of small-scale power generation has been much greater in the south of the UK due to the greater need for flexible power generation and other factors such as the availability of land and small differences in charging zones. However, as the south becomes saturated we are expecting to see a drive for development further North and into our network.

To date we have had well over one thousand connection enquiries from peaking plants but have had only ten projects completed. This is partly due to end users bidding on many fronts which makes these projects hard to get across the line, and partly due to the suspension of the capacity market in November 2018 following a legal challenge which led to almost a year of uncertainty during which time the power generation market has been flat.

In October this year the European Commission approved the UK Governments Capacity Market scheme and with the next capacity auction expected in February 2020 producers are predicting a positive outcome which will stimulate growth and get the sector moving again. With electricity demand forecast to rise to 2050 due to electric vehicles and growth across the heating sector, peaking plants will continue to be an important part of our energy landscape.

Unlike General and Specific reinforcement detailed earlier in this paper, we have only a few years of historic data, and the inherently unpredictable nature of these types of connections, makes forecasting the associated reinforcement costs difficult. We have built up our forecasts using a trend of the numbers of acceptances of connection quotations and the resulting proportion of completed projects where the Economic Test means we are required to contribute to the cost of the reinforcement. The graph below shows these trends.



The table below shows the results of the forecast workloads and uses the average cost of RIIO-1 reinforcement projects and the average split between NGN funded and customer funded elements to derive a total reinforcement cost for RIIO-2.

Peaking Plant Connections	Unit Cost (£m/project)	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 Total
No. of Accepted Projects	-	50	59	68	77	87	341
No. of Completed Projects	-	17	20	23	26	29	115
No. of Completed Projects with Reinforcement	-	5	6	7	8	9	35
No. of Completed Projects with NGN Funded Reinforcement	-	3	4	5	5	6	23
Total Cost to NGN of Reinforcement Projects	**£0.29**	**£0.88**	**£1.17**	**£1.46**	**£1.46**	**£1.75**	**£6.72**
Total Cost to Customer of Reinforcement Projects	**£0.10**	**£0.30**	**£0.40**	**£0.50**	**£0.50**	**£0.60**	**£2.30**
Total Cost of Reinforcement Projects	**£0.39**	**£1.18**	**£1.57**	**£1.96**	**£1.96**	**£2.35**	**£9.01**

We have back calculated the lengths of reinforcement from the total reinforcement costs using RIIO-1 splits between above and below 180mm mains and the RIIO-2 unit costs as specified earlier in this paper. The tables below show the results.

Specific Reinforcement (km)	NGN	Customer	Total	Unit Cost (£/km)	NGN	Customer	Total
Mains <180mm	16.7	5.7	22.5	£0.32	£5.44	£1.86	£7.30
Mains >180mm	3.8	1.3	5.1	£0.33	£1.28	£0.44	£1.72
Total	20.6	7.0	27.6	£0.66	£6.72	£2.30	£9.01

Our forecasts show that we expect to see reinforcement from peaking plant connections steadily rise year on year in RIIO-2. This forecast is based on the resolution of the capacity market legal issues, and the likelihood that our network will catch up with other regions in the building of peaking plants as restrictions developing in the south make our region more economical. However, as this market relies on the collaboration between energy companies, regulators and the government, forecasting the exact impact on our network is difficult. For this reason, we are proposing a Reopener, which in addition to the sharing mechanism, will limit the risk to our customers and to the network of under or over forecasting workload. For more information on the Reopener see Appendix A15 - NGN RIIO-2 Uncertainty and Risk.

8.2. Business Case Summary

Unit Costs – The tables below summarise the unit cost options for mains and district governors in RIIO-2.

£m/km	Option 1	Option 2
Mains	Split by general and specific	General and specific combined
General >180mm	£0.517	£0.325
General >180mm	£0.326	£0.333
Specific >180mm	£0.244	£0.325
Specific >180mm	£0.348	£0.333

£m/no.	Option 1	Option 2
Governors	Split by general and specific	General and specific combined
General	£0.063	£0.054
Specific	£0.006	£0.054

Our preferred option is Option 2 in both cases as a single unit cost, rather than one split between general and specific reinforcement, allows for the maximum number data points to be used.

Workload – The tables below uses the unit costs from Option 2 to summaries the reinforcement cost options for RIIO-2.

General Reinforcement	£m/km	Option 1 - Eleven Year Trends		Option 2 - Six Year Trends		Option 3 - Six Year Averages	
		Length (km)	Cost (£m)	Length (km)	Cost (£m)	Length (km)	Cost (£m)
Mains up to 180mm	£0.325	-20.5	-£6.7	13.7	£4.4	11.1	£3.6
Mains above 180mm	£0.333	-4.8	-£1.6	3.6	£1.2	9.3	£3.1
Totals		**-25.3**	**-£8.2**	**17.3**	**£5.6**	**20.3**	**£6.7**

Specific Reinforcement	£m/km	Option 1 - Eleven Year Trends		Option 2 - Six Year Trends		Option 3 - Six Year Averages	
		Length (km)	Cost (£m)	Length (km)	Cost (£m)	Length (km)	Cost (£m)
Mains up to 180mm	£0.325	29.5	£9.6	31.0	£10.1	15.6	£5.1
Mains above 180mm	£0.333	3.7	£1.2	4.1	£1.4	4.3	£1.4
Totals		**33.2**	**£10.8**	**35.1**	**£11.4**	**19.9**	**£6.5**

Our preferred option is Option 2 in both cases as it considers recent trends in growth as well as our approach to managing reinforcement that ensures we carry out the most efficient and cost-effective reinforcement scheme to maintain minimum design pressures within the network.

There was only one workload option proposed for District Governors, the table of workload and cost is shown below.

District Governors	£m/no.	Option 1 - Six Year Trends		Option 2 - Six Year Averages	
		Number	Cost (£m)	Number	Cost (£m)
General Reinforcement	£0.054	-10	-£0.5	12	£0.7
Specific Reinforcement	£0.054	-2	-£0.1	2	£0.1
Totals		**-12**	**-£0.7**	**14**	**£0.8**

9. Preferred Option Scope and Project Plan

9.1. Preferred Option

The below table details our reinforcement forecast workload and unit cost proposals for RIIO-2.

Reinforcement workload and unit cost in RIIO-2		Unit Cost (£/km / £/No.)	2021/22	2022/23	2023/24	2024/25	2025/26	Total Length (km) / No.
General Reinforcement	Mains up to 180mm	0.32	2.6	2.7	2.7	2.8	2.9	**13.7**
	Mains above 180mm	0.33	1.0	0.9	0.7	0.6	0.4	**3.6**
	District Governors	0.05	2.4	2.4	2.4	2.4	2.4	**12**
	District Governors (over capacity)	0.06	16.2	14.0	14.0	14.0	9.7	**68.0**
	Total Mains	-	**3.6**	**3.5**	**3.5**	**3.4**	**3.3**	**17.3**
	Total District Governors	-	**18.6**	**16.5**	**16.5**	**16.5**	**12.1**	**80.2**
Specific Reinforcement	Mains up to 180mm	0.32	5.3	5.8	6.2	6.6	7.1	**31.0**
	Mains above 180mm	0.33	0.8	0.8	0.8	0.8	0.8	**4.1**
	District Governors	0.05	0.4	0.4	0.4	0.4	0.4	**2**
	Mains up to 180mm (peaking plants)	0.32	2.9	3.9	4.9	4.9	5.9	**22.5**
	Mains above 180mm (peaking plants)	0.33	0.7	0.9	1.1	1.1	1.3	**5.1**
	Total Mains	-	**9.8**	**11.4**	**13.0**	**13.5**	**15.1**	**62.8**
	Total District Governors	-	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**2.1**

9.2. Asset Health Spend Profile

The below table details our reinforcement expenditure forecasts for RIIO-2.

Reinforcement Costs in RIIO-2		Unit Cost (£/km / £/No.)	2021/22	2022/23	2023/24	2024/25	2025/26	Total Cost (£m)
General Reinforcement	Mains up to 180mm	0.325	£0.8	£0.9	£0.9	£0.9	£0.9	**£4.4**
	Mains above 180mm	0.333	£0.3	£0.3	£0.2	£0.2	£0.1	**£1.2**
	District Governors	0.054	£0.1	£0.1	£0.1	£0.1	£0.1	**£0.7**
	District Governors (over capacity)	0.059	£1.0	£0.8	£0.8	£0.8	£0.6	**£4.0**
	Total Mains	-	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**£5.6**
	Total District Governors	-	**1.1**	**1.0**	**1.0**	**1.0**	**0.7**	**£4.7**
	Total Reinforcement	-	**2.3**	**2.1**	**2.1**	**2.1**	**1.8**	**£10.3**
Specific Reinforcement	Mains up to 180mm	0.325	£1.7	£1.9	£2.0	£2.2	£2.3	**£10.1**
	Mains above 180mm	0.333	£0.3	£0.3	£0.3	£0.3	£0.3	**£1.4**
	District Governors	0.054	£0.0	£0.0	£0.0	£0.0	£0.0	**£0.1**
	Mains up to 180mm (peaking plants)	0.325	£1.0	£1.3	£1.6	£1.6	£1.9	**£7.3**
	Mains above 180mm (peaking plants)	0.333	£0.2	£0.3	£0.4	£0.4	£0.4	**£1.7**
	Mains Contribution (peaking plants)	25.5%	-£0.3	-£0.4	-£0.5	-£0.5	-£0.6	**-£2.3**
	Total Mains	-	**2.9**	**3.3**	**3.7**	**3.9**	**4.3**	**£18.2**
	Total District Governors	-	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**£0.1**
	Total Reinforcement	-	**2.9**	**3.3**	**3.8**	**3.9**	**4.3**	**£18.3**
Totals		-	**5.2**	**5.5**	**5.9**	**6.0**	**6.1**	**£28.6**

The total forecast capital expenditure for Reinforcement can be referenced back to the following documents:

- RIIO-2 Business Plan document – table ref 6.6
- RIIO-2 Business Plan Data Tables – table ref 3.02

9.3. Investment Risk Discussion

We have controls and processes in place throughout the development of our RIIO-2 Capital Expenditure programme to ensure we mitigate both our customer's and our own exposure to risk. Workload and unit cost risks are inherent when forecasting third party driven work. The bullet points below outline the steps we have undertaken to ensure we limit these risks to provide an accurate capital programme.

Workload Risk Mitigations

- We have considered several options which forecast varying workload volumes and chosen the solution which best fits both historic and future trends.
- Where workload volumes are uncertain we have proposed an uncertainty mechanism to protect our customers from risk.
- We have shared our preferred strategy with our businesses industry experts to sense check volumes and costs.
- Our RIIO-2 strategy is comparable with our RIIO-1 strategy and so we have a proven record we can manage our network in this way.

Unit Cost Risk Mitigations

- We have considered several options for unit costs and chosen the option which considers the most data points used to derive the unit cost.
- Our proposed unit costs include for efficiencies delivered through innovation in RIIO-1.
- We have benchmarked our unit costs against other GDN's to ensure our unit costs are efficient.
- We have experienced Project Managers who have a proven track record of delivering this type of work in the past and we have a commercial team of quantity surveyors who are focussed on delivering value for money.