Cadent
Your Gas Network

Appendix 09.03 Services Not Associated with Mains Replacement

RIIO-2 Spend: XXXX

Investment Decision Pack Overview

This Asset Health Engineering Justification Framework outlines the scope, costs and benefits for our proposals. We have prepared an enhanced Engineering Justification Paper (EJP) and a Cost-Benefit Analysis (CBA) for these assets.

Overview

Service assets are the connections between our distribution mains and the customer's home. We currently have around 11 million service pipes supplying customers in domestic, industrial, commercial and multiple-occupancy buildings. Most of our service population is fully Polyethylene (PE) from the main to the meter, although some of the older steel assets are still functioning (pipes installed prior to the mid-1970s and 'steel tails' installed prior to the early 1980s). The proportion of PE is increasing through time and reactive work volumes are therefore decreasing.

We invest in these assets on an ongoing basis to ensure security of supply to customers and to manage safety risk (particularly risks associated with steel pipes). We have an absolute duty (Pipeline Safety Regulations, 1996) to ensure that pipes are maintained in an efficient state, in efficient working order and in good repair. We have analysed the volume of service renewals we will be required to perform in RIIO-2, based on different drivers:

- **Services Re-laid After Gas Escape:** Given the proximity of service pipes to customer homes and the high risk of gas from a failure entering the property, services are replaced on failure.
- **Re-laid Service Alterations:** This is a customer-driven activity associated with home improvements which require us to move our pipework (e.g. extensions).
- **Bulk Steel Service Re-lay:** This is pro-active work to replace services in areas with a high failure rate.
- **Other Services Re-laid:** This work is customer-driven, with most of the work being to address poor-pressure issues caused by the growth in customers' demand for gas.

We are mandated to perform this work; our do-minimum option of reactively fixing following a failure or as a result of a customer request is our chosen option for all work-types except Bulk Steel Service Re-lays. A proactive approach for our Bulk Steel Service Re-lays has been chosen to improve delivery efficiency. Overall, our options are relatively few; the work is low tech and low cost, with limited opportunities for innovation.

Nonetheless, we have considered the work through the lens of CBA. Consistent with the NARMs methodology, we have monetised the benefits of intervention and applied these benefits to the volume of interventions proposed. The benefits include environment (GHG emissions), safety (prevention of injuries and death), interruptions to supply and financial impacts (avoided costs of repair and replacement).

Taking account of these benefits, and the costs of intervention, our analysis shows that the forecast programme of work is cost-beneficial (for each network individually, and in total). The largest driver of benefit is safety – this is to be expected as these assets are in very close proximity to customers' properties. A summary of expenditure and NPV for this investment is provided in the table below.

Summary of preferred option	£
RIIO-2 Expenditure (Repex)	Redacted due to commercial sensitivity
Project NPV	

Material Changes Since October Submission

There have been no material changes since October.

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2. Introduction

This document provides the investment case methodology for investment required on non-mains related service interventions, i.e. services not replaced as part of our mains replacement programme. The scope of this document is domestic and non-domestic services, the pipe from the meter at the property to the connection with the gas main.

This document covers the four areas of investment detailed in the table below. We have considered them together as they are on the same asset base, draw from similar data and are affected by similar factors.

Name	Description
Bulk Steel Replacements	Safety-driven, proactive service renewal which is not associated with mains replacement
Re-laid Service Alterations	Customer-driven service alteration activity (e.g. because of customer home improvement work mandating movement of our asset)
Services Re-laid After Escape	Replacement of services after they have leaked
Other Services Re-laid	Replacement of services which are non-leak-related (e.g. poor pressure) issues

Table 1: Investment Areas Covered in this EJP

To understand the investment needs of these high-volume, low-cost activities we have used the RIIO-1 volumes and cost data reported in RRP to interrogate failure rates and understand how our assets are performing as well as considering the mains renewal activities which will impact on some categories of service re-lays.

Our data for services not associated with mains replacement is of good quality as it is reported in the RRP to Ofgem annually. This gives us high confidence in the forecasts we have produced for RIIO-2.

Our RIIO-2 forecasts, as well as adjusting for workload and work mix factors, also include ongoing efficiencies flowing from our transformation activities including from updating and renewing our contracting strategies. Our initiatives are outlined in Appendix 09.20 Resolving our benchmark performance gap. For Repex activities this seeks a 5% efficiency improvement by 2025/26 on the end of RIIO-1 cost efficiency level. Applying this results in a XXXX efficiency over 5 years, to this investment area. All costs in this document are post efficiency.

Note that investment associated with unauthorised connections is not included in this document but rather is grouped with our new-connections investment.

3. Equipment Summary

We have 11 million service pipes supplying customers in domestic, industrial, commercial and multiple occupancy buildings directly from the network. The service pipe is the last part of the network connecting distribution mains to customers' meters. The following table shows the breakdown by network:

Network	EoE	Lon	NW	WM
Number of services ('000s)	4,024	2,275	2,693	1,965

Table 2: Service Asset Base as per RRP 2018-19

Services were laid almost entirely in steel until the introduction of Polyethylene (PE) in the mid-1970s. Services are now laid exclusively in PE, except where the pipe is to be above ground or there are other specific engineering challenges.

Figure 1: Yellow PE service tee off Steel mains

Most of our current service population is fully PE from the main to the meter, although some of the earliest types of PE services were laid with a steel house entry (referred to as a 'steel tail'). This occurred from the mid-1970s to the early 1980s when house-entry fittings allowing PE up to the ECV (Emergency Control Valve) were not available.

The table below shows the approximate distribution of the 11 million services by material type:

Network	EoE	Lon	NW	WM
PE ('000s)	3,603	2,018	2,364	1,690
Steel ('000s)	392	246	308	263
Mixed (PE + Steel Tail) ('000s)	29	11	20	12

Table 3: Service Asset Base by Material Type as per RRP 2018-19

Services of all material types will typically be of ¾" to 1½" internal diameter, although some industrial and commercial services are larger. These larger services (2" diameter and above) are selected for replacement in accordance with mains-replacement criteria and therefore excluded from this investment case.

4. Problem Statement

Service assets are the connection between our distribution network and the customer's home and therefore play a unique role in the distribution system as the assets are a customer's single source of supply and on their property right up to the ECV, which is generally situated on the customer's premises.

We invest in these assets to ensure security of supply to customers and to manage safety risk.

Our ongoing requirement to address the risks associated with our services, especially the remaining steel service population is recognised in key safety-related Legislation such as the Pipeline Safety Regulations (PSR) and the Health and Safety at Work Act (HASWA).

In addition to addressing process risk associated with steel services, other reactive drivers of renewal include poor-pressure problems, third-party damage and activity driven by customers, such as meter-box alterations.

The investment types covered in this document are:

Investment Type	Name	Description
Proactive Safety Investment	Bulk Steel Replacements	Safety-driven, proactive service renewal which is not associated with mains replacement
Reactive Investment	Re-laid Service Alterations	Customer-driven service alteration activity
	Services Re-laid After Escape	Replacement of services after they have leaked
	Other Services Re-laid	Replacement of services which have non-leak-related (e.g. poor pressure) issues

Table 4: Investment Types and Descriptions

Required outcomes: We consider the do-nothing position to be unacceptable. It does not ensure that we comply with our fundamental safety obligations, we would be non-compliant with PSR, to the public and our employees, which are associated with the Health and Safety at Work Act 1974 and are important to our customers and stakeholders.

We want our customers to be confident in the pipework connecting their property to our network. This pipework is on their property and if it fails, it will cut off their supply and put their safety at risk. Customers and stakeholders have consistently told us that worsening levels of reliability and network security is not in line with their preferences.

In summary, the required outcomes for this investment are a safe and reliable system.

We will consider our investment plans to be acceptable and appropriate only if these outcomes are met.

4.1. Narrative: Real Life Example of Problem

As discussed in the previous section, service assets are very close to customer properties and are generally situated on the customers' premises. The result of this is that gas escapes can lead to gas in building (GIB) events, which are the precursors to an incident (explosion).

The chart below shows the number of incidents (explosions) caused by mains and services through time. This data is collected by the National Replacement Forum. The 15 incidents that were attributable to service pipes caused three fatalities.

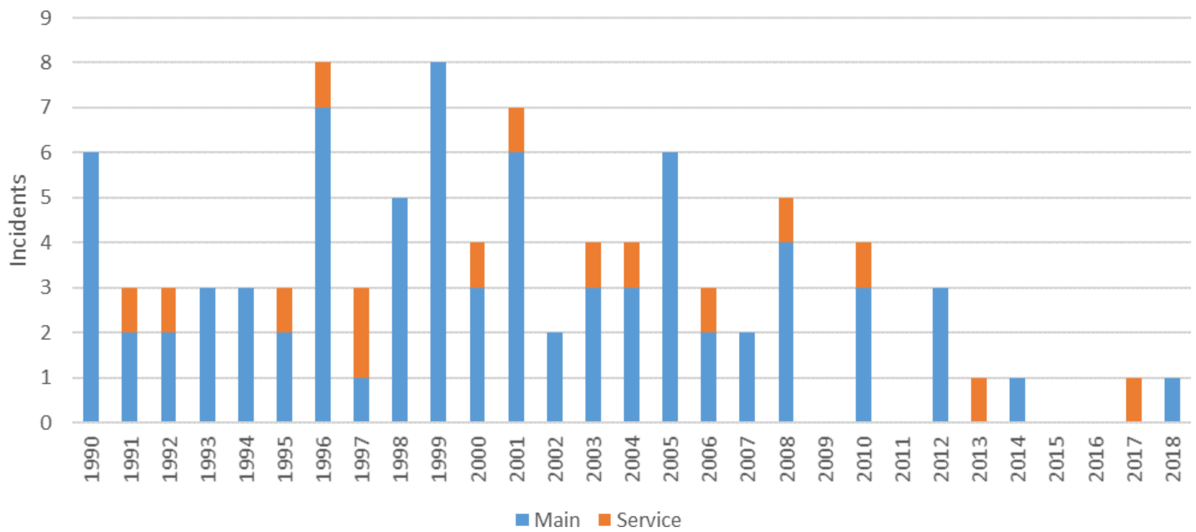


Figure 2: Incidents (explosions) Caused by Mains and Services Through Time (All GDNs)

The below example is a summary of an incident that happened in Shropshire in 2010 as investigated by the HSE[1], where an escape from a gas main caused an explosion severely injuring 6 people. This incident was caused by a 9" main. However, the impact of the gas escape, if caused by a service pipe, would be the same.

At approximately 11.26 am on Sunday 3rd January 2010, an explosion and subsequent fire destroyed 1-5 Bridge Street, Shrewsbury, Shropshire. Six people suffered major injuries, several others suffered minor injuries. A number of properties in the area were also significantly damaged and Shrewsbury Town Centre was partially closed for several days causing disruption for local residents and businesses.

Figure 3: The Shrewsbury gas explosion on Sunday, January 3, 2010

All four occupants of 1-5 Bridge Street suffered major injuries when they were either thrown from the building or buried in the debris. The explosion damaged the north and west sides of the property. Debris

[1] http://www.hse.gov.uk/gas/supply/shrewsbury-explosion-report.pdf

was thrown some distance from the building into the neighbouring Shrewsbury Hotel car park and the surrounding areas. There were a number of vehicles parked at the Shrewsbury Hotel.

A family of six were near or within their car in the car park at the time of the explosion. Two of them suffered major injury from flying debris. Many of the neighbouring buildings suffered damage due to the debris; this was primarily damage to windows and facade areas rather than significant structural damage. The explosion damaged other utilities within the Bridge Street area (e.g. telecommunications infrastructure and traffic light systems).

Key conclusions that emerged from the subsequent investigation were as follows:

- Mains gas leaked from a fractured low-pressure cast-iron gas main located in the footway immediately in front of 1-5 Bridge Street.
- The gas accumulated within 1-5 Bridge Street.
- The gas was ignited by a source within the building, leading to the explosion.
- The particular ground conditions, including the corrosive nature of the soil and the stresses imposed by structures near to the main, may have contributed to the unpredicted failure of the main.

HSE’s investigation has concluded that National Grid Gas (now Cadent) had correctly applied their gas mains maintenance procedures in relation to the low-pressure main. The main had been appropriately risk assessed and was not subject to leakage reports, thus not identified for proactive replacement prior to the incident.

This example, whist not being caused by a service, underlines the consequences of failure. It demonstrates the importance that assets in close proximity to people are well managed and maintained. Note most GIBs are from service leakage.

4.2. Spend Boundaries

The spend detailed in this paper is for the replacement of service pipes. The detailed costs cover all materials, labour, management and overheads associated with this activity.

Services pipes replaced with mains replacement are excluded.

Investment associated with unauthorised connections is not included in this document but rather is grouped with our new-connections investment.

5. Probability of Failure

This investment is reactive, except for bulk steel replacement. The trigger for a service replacement varies by activity type (as detailed above), but all result in the replacement of the service.

The charts below show the actual volume of service renewal, as reported in Table 5.3 of the RRP, since the start of the RIIO-1 price control period, except for the bulk steel renewal, as this started mid-period. The volume shown for bulk steel renewal is the number of steel services identified for renewal rather than the number renewed in each of the years.

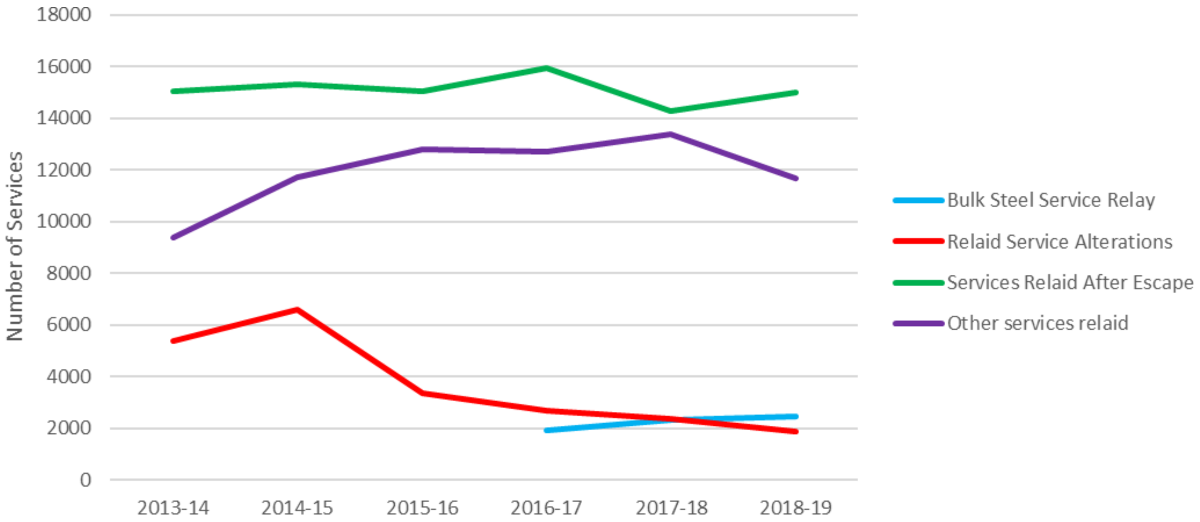
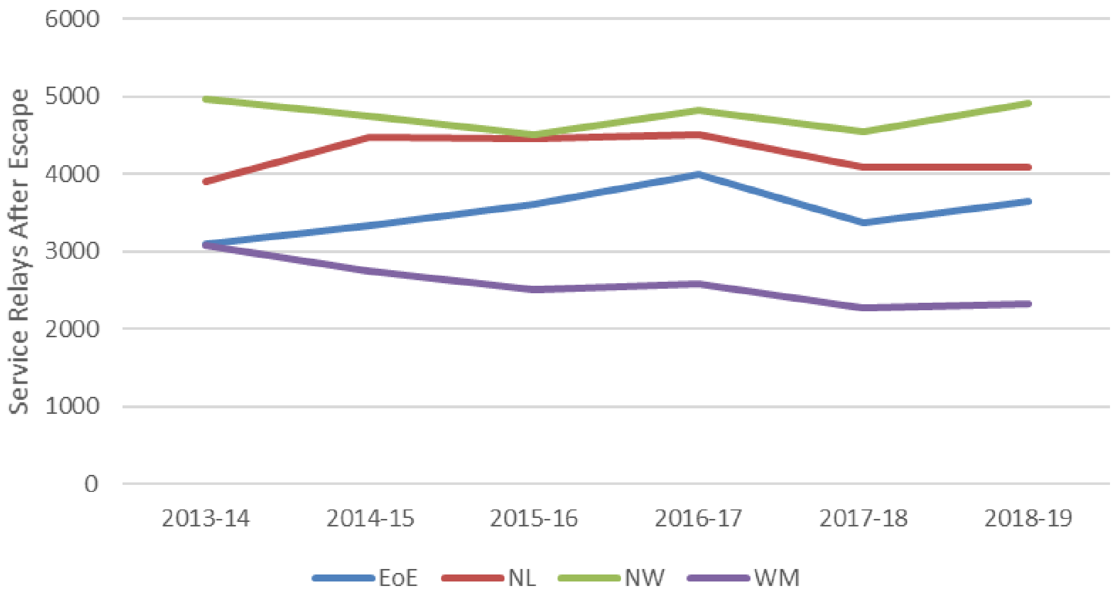


Figure 4: RIIO-1 Service Replacement Volumes

We have explored the failure rate by network for services in each of the categories above. The exception to this is for bulk-steel surveys as these are proactive interventions and therefore there is no failure rate.

Re-lay After Escape: Re-lay after escapes are trigged when there is a gas escape (leak) from the service. We respond by replacement of the asset with a new PE service. Third party damage to service pipes also result in relay and are classed as relays after escapes.

The charts below show the number of re-lays after escapes and the re-lays after escapes per steel service for each network. The normalised data removes variance associated with network size and changes in asset base through time as assets are replaced.



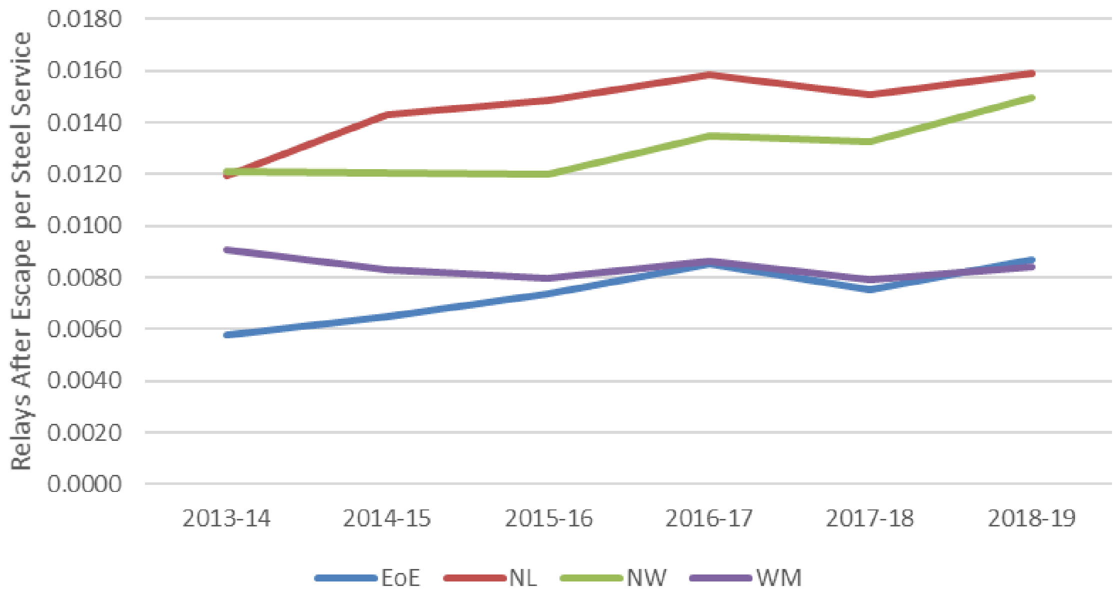


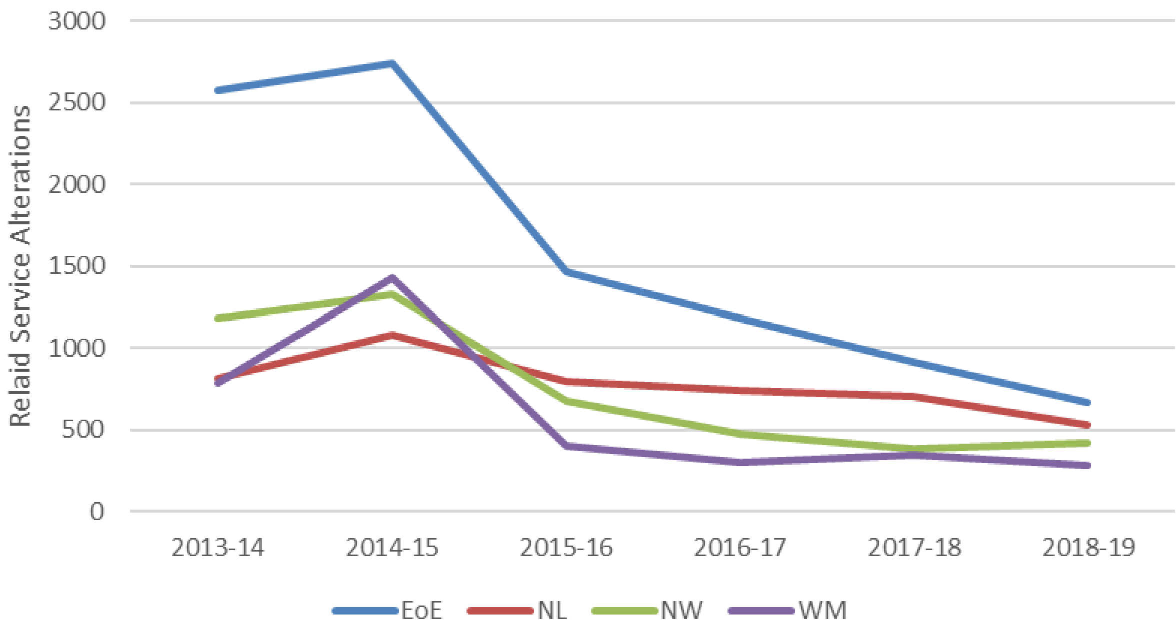
Figure 5: Re-lay After Escape per Network

There are yearly variations in the number of re-lays after escapes caused by factors such as weather. However, the general trend across networks is that the number of re-lays per annum is broadly flat.

Most of the re-lays after escapes are on metallic assets. In the chart, the number per steel service in the asset base is shown. From this chart, it is possible to see that there is underlying deterioration in the steel service population. This deterioration is an effect of an ageing asset population.

The underlying deterioration is offset by a reduction in the asset population as mains and their associated steel services are replaced (hence the relatively flat profile for re-lay after escape). In addition, there is a failure benefit of transferring PE services from metallic mains to PE mains as a more robust joint can be created.

Re-laid Service Alterations: The charts below show the number of service alteration re-lays and the service alterations per service for each network.



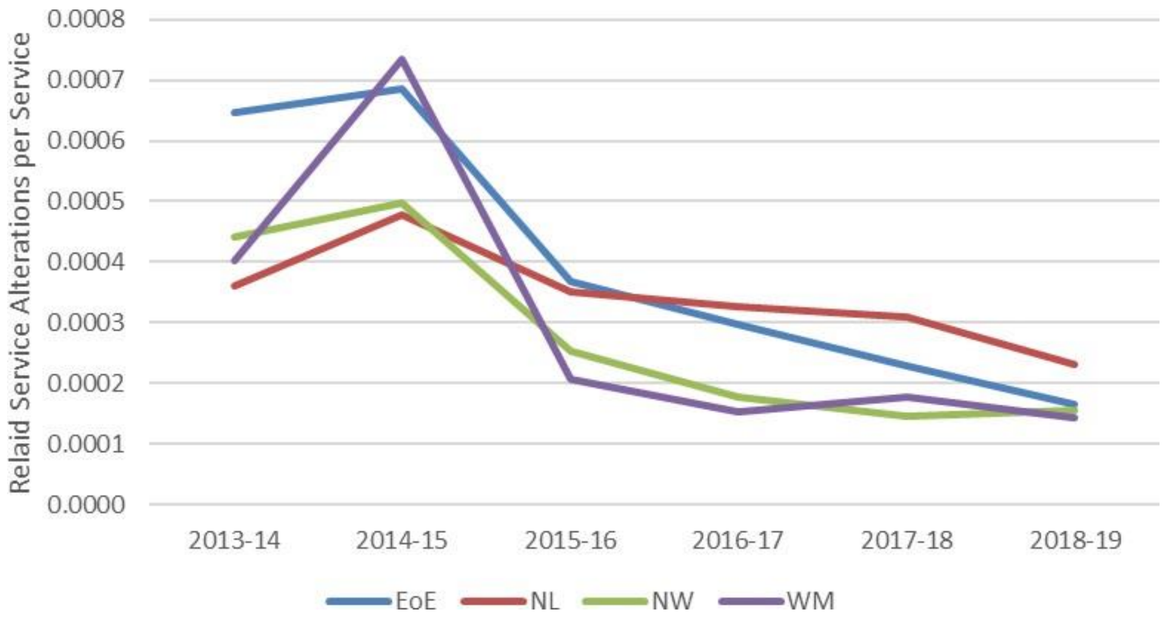
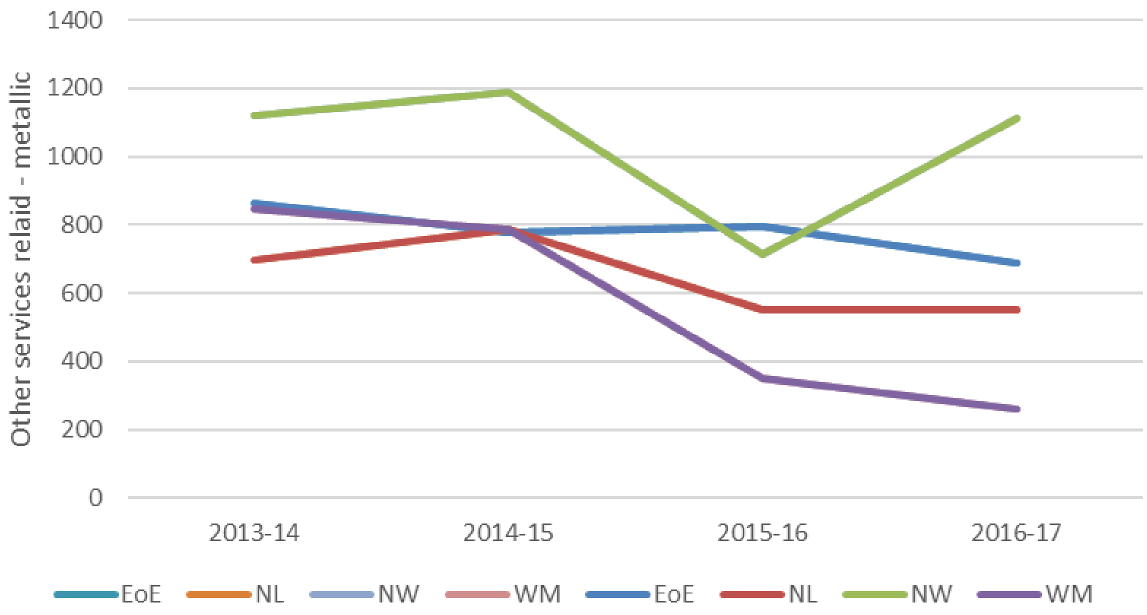


Figure 6: Re-laid Service Alterations per Network

Service alterations are a customer-driven activity, because of this there is a large variation in the number of alterations per year. As this activity is a customer-driven investment in mains renewal, it is not expected to impact the re-lay forecast. Some alterations are for existing PE services.

Other Services Re-laid: The charts below show the number of "other services re-laid" (metallic and non-metallic) and the "other services re-laid per service" for each network.

For metallic the re-lays per service used the steel service asset population to calculate the re-lay rate and for the non-metallic, the PE service population is used.



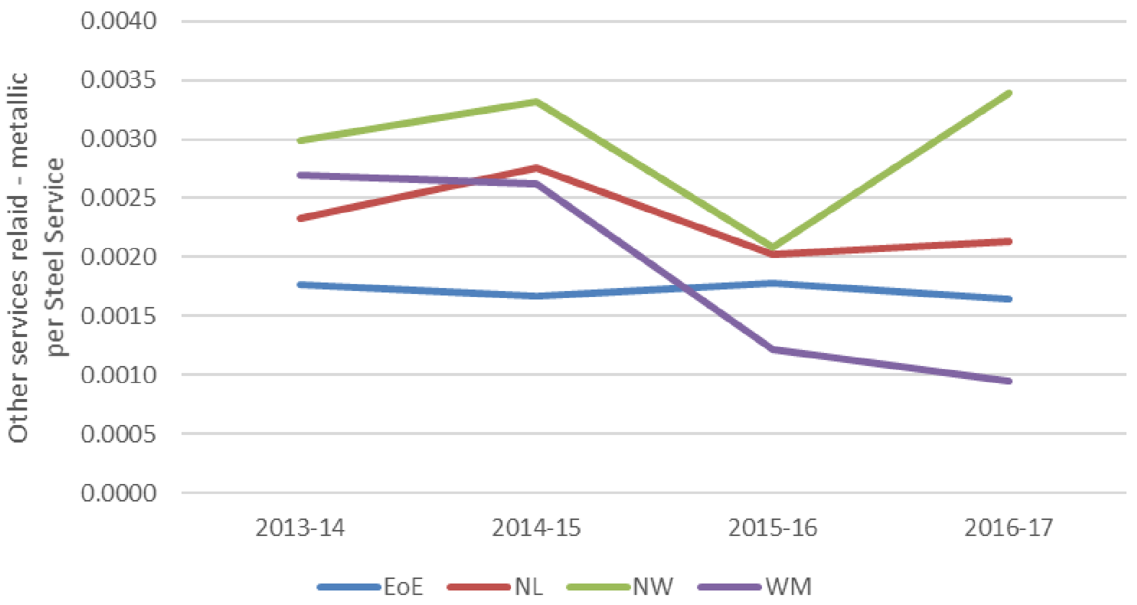
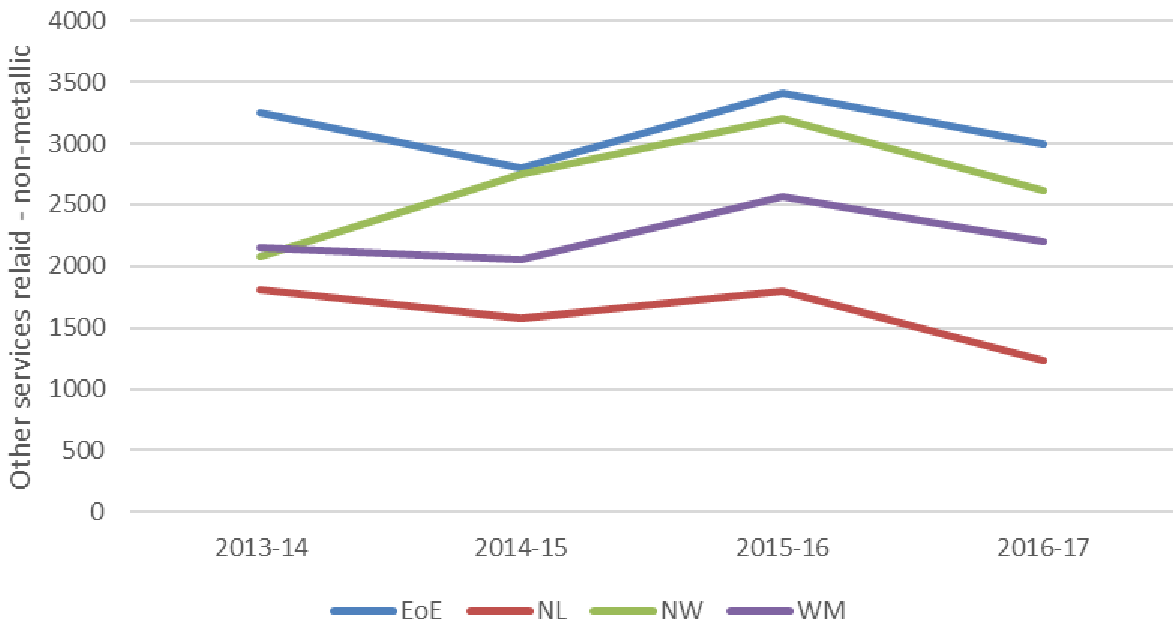


Figure 7: Other Service Re-laid (Metallic) per Network



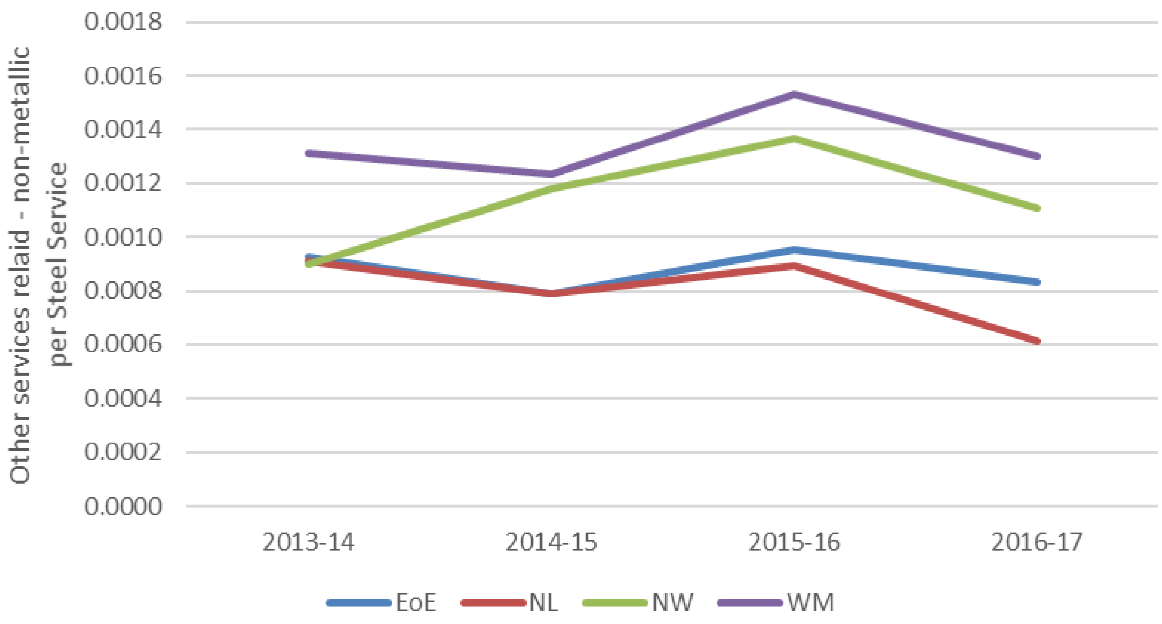


Figure 8: Other Service Re-laid (Non-Metallic) per Network

There are yearly variations in the number of other service re-lays. However, the general trend across networks is that the number of re-lays per annum is broadly flat. A generally flat profile is expected as the cause of these re-lays are generally pressure related. The re-lays per service charts do not show signs of underlying deterioration.

In the charts, there is more PE replacement than steel replacement; this is because there is a larger PE asset base. However, once normalised, the steel assets have a higher replacement rate.

For RIIO-2, the mains replacement plan will be considered to forecast future re-lay volume. The reason for this is that the asset population of metallic mains will be significantly reduced over RIIO-2 because of the mains renewal programme.

5.1. Probability of Failure Data Assurance

Failure data and asset population data have been extracted from our annually submitted RRP reports, which originate from our core data systems. The data reported in the RRP has been through the data assurance process, ensuring the business has confidence in the values reported.

As this is a high-volume activity that is well captured in our core data systems and reported in RRP, we have a high confidence in the failure data we have used to forecast the volume of service replacements for RIIO-2.

6. Consequence of Failure

Service failures can have several consequences such as:

Supply interruptions: As the service pipe is a single point of supply for a customer, the failure of the service to carry gas will result in an interruption.

Despite a generally flat number of service re-lays per annum, we have seen a reduction in the number of gas interruptions. This is a result of improved working practices to keep customers on gas while their services are repaired.

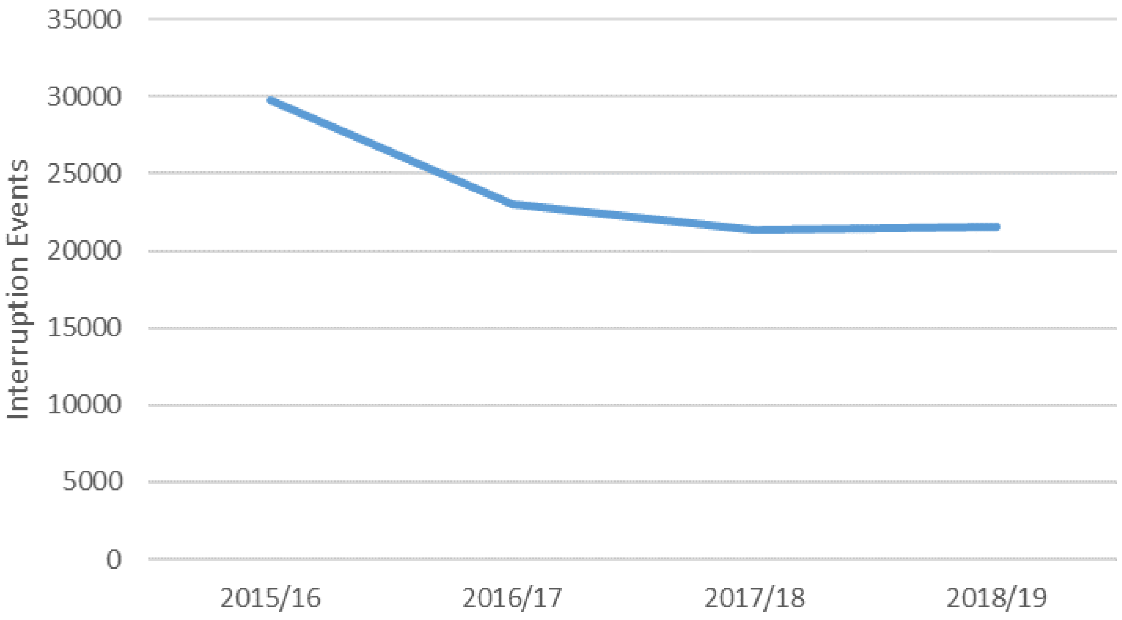


Figure 9: Number of Service Interruption Events in RIIO-1 as per RRP

Gas in buildings (GIBs): as the service pipe is in very close proximity to buildings by necessity, the escape of gas from an asset can lead to GIBs. This is hazardous, as a build-up of gas in a confined space can lead to an explosion which can lead to injury or the loss of life. See the real-life example in section 4.1.

Our data shows that the number of GIBs caused by services has been variable over RIIO-1. The data also shows that services are the largest contributor to GIBs overall, with 73% of GIBs originating from services. As discussed in Section 4.1, GIBs can and lead to incidents and fatalities.

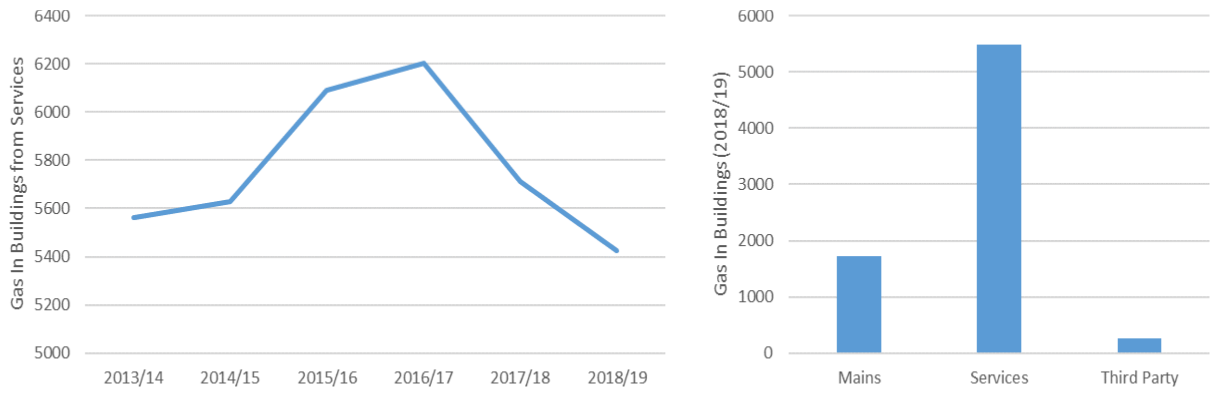


Figure 10: Number of "Gas in Buildings" in RIIO-1 as per RRP (relating to services)

Environment: the failure of services also has an impact on the environment due to the loss of gas.

To value the investment in services (non-mains related), the NARMs methodology has been used. Each potential consequence has been expressed as a monetary value as per the agreed industry methodology, as shown below:

Customer Driver	Data Source
Environment – GHG emissions (unit)	UK Government: Value agreed with Ofgem
Safety – injuries and deaths (unit)	UK Government (HSE): Value agreed with Ofgem
Leakage – commercial value of lost gas (unit)	Shippers: Value agreed with Ofgem
Emissions - Carbon and equivalents	UK Government values used
Financial impact – cost of repairs (unit)	Company accounts
Financial impact – cost of replacement (unit)	Company accounts

Table 5: Sources of societal benefits

We have also included the financial consequences associated with fixing failures as they occur (e.g. repair costs) and remedying the consequences of failures (e.g. compensation and prosecution). Our financial impacts are based on a robust assessment of our costs.

7. Options Considered

Introduction

Within this investment case, there are three different work types. Two of these work types are driven by poor performance or service-pipe failure (Types A and B). Work type C is driven by customer requests to move service pipes.

- **Type A: Remediation of service-pipe after a gas escape**: A gas-leak is identified which results in the need to remediate the service pipe. The gas service-pipe has failed due to deterioration.
- **Type B: Remediation of service pipe following some other performance issue:** This intervention is typically triggered by poor pressures.
- **Type C: Re-laid Service Alterations:** Customer wants their gas service-pipe re-laying because they are carrying out building modifications. This work is carried out at the customer's request and is not driven by asset health.

For each of the above work-types, we have considered a number of solution-options. The activity of service replacement is low cost and low tech. We have examined spray-lining techniques but have not identified a suitable structural spray liner (the HSE will not accept semi-structural liners) which would allow us to move away from PE pipes. The preferred option is therefore to replace the entire service pipe. The material costs are small in comparison to the overall labour, mobilisation and plant costs. A replacement option gives us certainty that the service pipe is in good condition and no further safety risks will occur for the foreseeable future.

When designing service alterations, we will work closely with customers to see how we can minimise costs and disruption. However, utility pathways are usually a low priority when it comes to home improvements. We routinely make use of no-dig techniques such as horizontal directional (mole) drilling to reduce costs and disruption. We are therefore confident that a service replacement, using appropriate no-dig techniques where possible, delivers the optimum balance between cost, design-life, certainty of remediation and therefore customer safety.

For each of these work types we have considered the following options:

Work Type	Options considered
A: Remediation of service-pipe after a gas escape	For each individual service-pipe fault /failure we look to replace upon failure. These are referred to as ***Services Re-laid After Escape***. Regulation 13 of the Pipelines Safety Regulations 1996 (PSR) requires the operator of a pipeline to ensure that it is maintained in an efficient state, in efficient working order and in good repair. This duty is absolute, and, in the case of steel service pipes, maintenance means replacement. Where we identify a specific neighbourhood or area that has had a high volume of failures of steel service pipes (in RIIO-1 these have been 5 times greater than the average failure rate by network), we use this as an indicator of the service pipes all being at 'end-of-life'. In this situation, we look to proactively replace all service-pipes in the area. This is a new initiative introduced in RIIO-1 and therefore we are not proposing to change the approach until we have delivered the work for a period and have been able to assess the benefits. We refer to this as ***Bulk Steel Service Re-lay.***

Work Type	Options considered
B: Remediation of service pipe following some other performance issue	For each individual fault/failure (in this instance poor pressure often due to the growth in demand for gas in a specific area), we look to carry out a reactive replacement of the service pipe. These are referred to as ***Other Services Re-laid.*** We have not considered a proactive replacement option for these issues.
C: Re-laid Service Alterations	Following a customer contact, we carry out a re-lay of their service-pipe. This re-lay is driven by the customer carrying out alterations on their property, necessitating a different service pipe layout. These are referred to as ***Re-laid Service Alterations*** No proactive option exists.

Table 6: Options considered for Service Re-lays

To forecast the number of service repairs we would expect in RIIO-2, we have used the RRP Table 5.3 trends combined with the investment we are making in distribution-mains renewal. The process we have followed for each of the lines is explained in each of the following option summaries.

7.1 Services Re-laid after escape

This work is driven by asset health. As the service pipes age, the rate of failure is expected to increase. However, our mains renewal programme is counteracting this through the renewal of mains-associated services.

For RIIO-2, we have taken the average replacement over the past three years (2016/17 – 2018/19) for domestic workload and the latest years data for non-domestic (as this is showing a reduction through time) and applied a top-down workload reduction of 2.5% year on year (average reduction in past three years) to account for the delivery of the mains renewal programme.

Network	2016-17	2017-18	2018-19	Average
EoE	3,988	3,364	3,653	**3,660**
Lon	4,515	4,095	4,090	**4,192**
NW	4,829	4,553	4,920	**4,748**
WM	2,590	2,274	2,317	**2,371**
Cadent	**15,922**	**14,286**	**14,980**	**14,971**

Table 7: Relay After Escape in RIIO-1

The proposed volumes for RIIO-2 are therefore as detailed in the table below:

Network	2021-22	2022-23	2023-24	2024-25	2025-26	Total
EoE	3,568	3,479	3,392	3,307	3,225	**16,972**
Lon	4,087	3,985	3,885	3,788	3,693	**19,438**
NW	4,629	4,514	4,401	4,291	4,183	**22,018**
WM	2,312	2,254	2,198	2,143	2,089	**10,997**
Cadent	**14,597**	**14,232**	**13,876**	**13,529**	**13,191**	**69,425**

Table 8: Relay After Escape in RIIO-2

The proposed capex expenditure for Relay After Escape in RIIO-2 is:

Services Overall						
	2021/22	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**Total**
EoE						
Lon						
NW						
WM						
Cadent						

Table 9: Spend by Year for Relay After Escape in RIIO-2

7.2 Bulk Steel Service Re-lay

The bulk steel process identifies locations with high service-failure rates and proactively promotes the renewal of the steel mains in an area to ensure the highest-risk areas are targeted. This is a new initiative introduced in RIIO-1 and therefore we are not proposing to change the approach until we have delivered the work for a period and have been able to assess the benefits.

To identify the volume of work to promote for RIIO-2 we have used the results of the surveys we have carried out to date to identify steel services that need replacement through this initiative. The volume of services this promotes will not reduce through mains replacement activity and therefore we have used the average volume over the past years to forecast workloads.

Network	2016-17	2017-18	2018-19	Average
EoE	279	224	257	**253**
Lon	1,324	1,105	1,124	**1,184**
NW	156	853	924	**889**
WM	140	136	136	**137**
Cadent	**1,899**	**2,318**	**2,441**	**2,463**

Table 10: Bulk Steel Services Identified for Replacement in RIIO-1

The proposed volumes for RIIO-2 are therefore as detailed in the table below. This workload is informed by the work we have carried out in RIIO-1 which shows that our London network has a higher concentration of assets that would be targeted by the bulk steel service renewal programme.

Network	2021-22	2022-23	2023-24	2024-25	2025-26	Total
EoE	253	253	253	253	253	**1,265**
Lon	1,184	1,184	1,184	1,184	1,184	**5,920**
NW	889	889	889	889	889	**4,445**
WM	137	137	137	137	137	**685**
Cadent	**2,463**	**2,463**	**2,463**	**2,463**	**2,463**	**12,315**

Table 11: Bulk Steel Services in RIIO-2

The proposed capex expenditure for Relay After Escape in RIIO-2 is:

Services Overall						
	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Cadent						

Table 12: Spend by Year for Bulk Steel Services in RIIO-2

7.3 Re-laid Service Alterations

This is a customer-driven activity and is not affected by the replacement of services through the mains renewal programme. We have observed a decrease in the volume of service alterations over RIIO-1. However, the rate of reduction has slowed. We have therefore used the last available year of data (2018/19 - minimum volume experienced in RIIO-1) to forecast the work into RIIO-2. Using an average volume over RIIO-1 would have led to a higher volume in the forecast.

Network	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
EoE	2,578	2,739	1,470	1,186	916	664
Lon	818	1,084	796	739	704	527
NW	1,180	1,332	679	474	388	418
WM	787	1,433	403	301	349	280
Cadent	**5,363**	**6,588**	**3,348**	**2,700**	**2,357**	**1,889**

Table 13: Re-Laid Service Alterations Activity in RIIO-1

The proposed volumes for RIIO-2 are therefore as detailed in the table below

Network	2021-22	2022-23	2023-24	2024-25	2025-26	Total
EoE	664	664	664	664	664	**3,320**
Lon	527	527	527	527	527	**2,635**
NW	418	418	418	418	418	**2,088**
WM	280	280	280	280	280	**1,400**
Cadent	**1,889**	**1,889**	**1,889**	**1,889**	**1,889**	**9,443**

Table 14: Re-Laid Service Alterations Activity in RIIO-2

The proposed capex expenditure for Relay After Escape in RIIO-2 is:

Services Overall						
	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Cadent						

Table 15: Spend by Year for : Re-Laid Service Alterations Activity in RIIO-2

7.4 Other Services Re-laid

This work is customer-driven, with most of the work being to address poor-pressure issues caused by the growth in customers demand for gas. We saw an increase in workload over the first years of RIIO-1, with a flattening off and decrease in the 2018/19 reported numbers. To forecast RIIO-2 volumes, we have used the last available year of data (minimum volume in recent years) to forecast the work into RIIO-2. This work is split into PE and Non-PE renewal. On the Non-PE workload, we have applied a top-down workload reduction (as per relay after escape but only on metallic service activity) to account for the delivery of the mains renewal programme.

Network	2015-16	2016-17	2017-18	2018-19
EoE	4,112	3,570	4,205	3,682
Lon	2,500	2,358	2,343	1,784
NW	3,194	3,940	3,921	3,728
WM	3,002	2,840	2,918	2,457
Cadent	**12,808**	**12,708**	**13,387**	**11,651**

Table 16: Other Services Re-Laid Activity in RIIO-1

The proposed volumes for RIIO-2 are therefore as detailed in the table below

Network	2021-22	2022-23	2023-24	2024-25	2025-26	Total
EoE	3,665	3,648	3,632	3,616	3,600	**18,162**
Lon	1,770	1,756	1,743	1,731	1,718	**8,718**
NW	3,700	3,673	3,647	3,621	3,596	**18,236**
WM	2,450	2,444	2,438	2,432	2,426	**12,191**
Cadent	**11,586**	**11,522**	**11,460**	**11,399**	**11,340**	**57,307**

Table 17: Other Services Re-Laid Activity in RIIO-2

The proposed capex expenditure for Relay After Escape in RIIO-2 is:

Services Overall						
	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EoE						
Lon						
NW						
WM						
Cadent						

Table 18: Spend by Year for : Other Services Re-Laid Service Activity in RIIO-2

7.5 Chosen Options Component Technical Summary Table

As discussed previously, for each work-type discussed above, there is only one feasible technical solution available, which is to relay the steel gas service with a PE service pipe and this is done using mature approaches that seek to minimise cost and disruption to customers as much as possible. For this reason, the following table will summarise the preferred option for each of the work types, but these are not comparative.

	Services re-laid after escape	Bulk Steel Service Re-lays	Re-laid service alterations	Other Services re-laid
Chosen option **(only technically feasible solution)**	Replace after failure	Proactively replace service pipes in areas with failure rates 5 times higher than average.	Replace after customer request	Replace after failure
First year of spend	2021	2021	2021	2021
Last year of spend	2026	2026	2026	2026
Volume of interventions (m)	69,425	12,315	9,443	57,307
Design life	45 years	45 years	45 years	45 years
Total spend request (repex)		Redacted due to commercial sensitivity		

Table 19: Technical Summary Table

7.6 Chosen Options Component Cost Summary Table

As discussed previously, for each work-type discussed above, there is only one feasible technical solution available. For this reason, the following table will just summarise the preferred option for each of the work types, but these are not comparative.

	21/22	22/23	23/24	24/25	25/26	Total
Services re-laid after escape						
Bulk steel service re-lays		Redacted due to commercial sensitivity				
Re-laid service alterations						
Other services re-laid						

Table 20: Cost summary table

The proposed RIIO-2 expenditure has been shown graphically, to aid comparison to RIIO-1 expenditure.

The volume of interventions forecast can be seen in the chart below. The graph clearly shows how the RIIO-2 programme is an extension of currently observed activity trends.

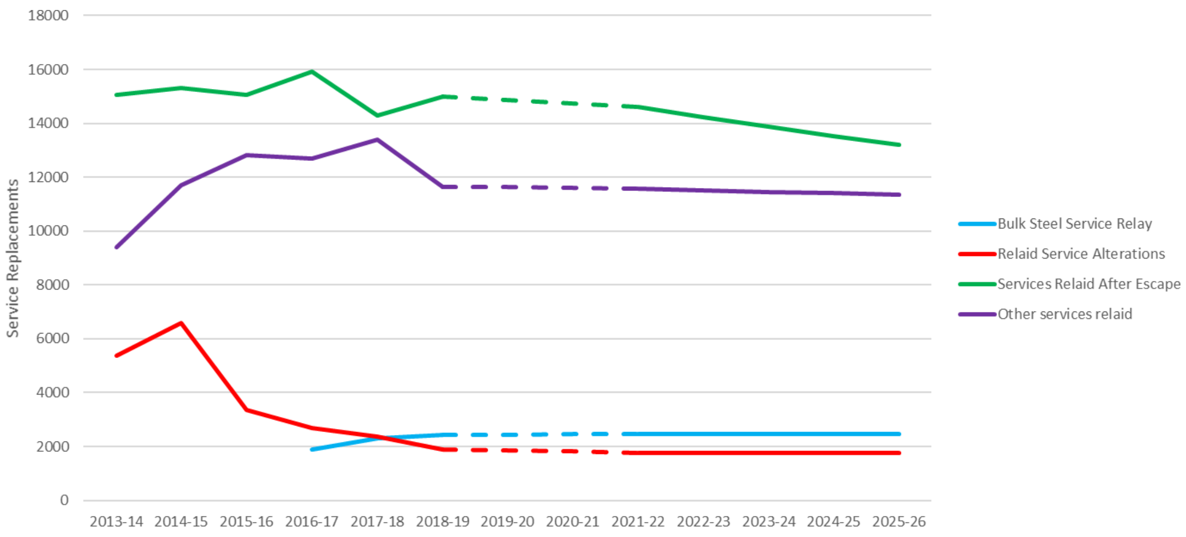


Figure 11: Forecast Service Replacement Volume (not associated with mains replacement)

Unit Costs for each service re-lay

We have used RIIO-1 actual unit cost data as reported in RRP to forecast the cost of the service replacement activity for RIIO-2. On top of this, we have applied a top-down efficiency.

The process we have followed for each of the lines is as follows:

- **Re-laid Service Alterations, Services Re-laid After Escape, Other Services Re-laid:** We have used the average unit cost for this activity over the past three years (2016/17 – 2018/19) to forecast the cost for RIIO-2.
- **Bulk Steel Service Re-lay**: We have used the service re-laid after escape unit costs to inform the RIIO-2 plan. The service re-laid after escape is an analogous work activity to bulk steel service renewal in that the entire asset is replaced.
- **Other Services Re-laid:** We have used the average unit cost for this activity over the past three years to forecast the cost for RIIO-2.

In summary, our average unit costs for all service activity by network (pre-efficiency) are detailed in the table below. London has a higher unit cost as working in the capital has challenges associated with London pay, access to road space, increased congestion in the ground limiting use of best practices, parking bay suspensions, increased reinstatement costs congestion charging and higher traffic management hire costs.

Name	EoE	Lon	NW	WM
Cost per Service		Redacted due to commercial sensitivity		

Table 21: Cost per Service, post-efficiency, 2018/19 price base

Our RIIO-2 forecasts include ongoing efficiencies flowing from our transformation activities, including those from updating and renewing our contracting strategies. Our initiatives are outlined in Appendix 09.20 Resolving Our Benchmarked Performance Gap. For repex activities, this seeks a 5% efficiency improvement by 2025/26 on the end-of-RIIO-1 cost efficiency level.

Year	2021/22	2022/23	2023/24	2024/25	2025/26
Efficiency	0.7%	2.8%	4.3%	4.6%	5.0%

Table 22: Ongoing Efficiencies Applied to Repex

8. Business Case Outline and Discussion

8.1. Key Business Case Drivers Description

This investment addresses process risk associated with steel services as well as other reactive drivers of renewal, including poor-pressure problems, third-party damage and activity driven by customers, such as meter-box alterations.

The benefits of this investment will be that assets will not be left to fail and therefore customers will be kept safe and performance issues such as poor pressure will be rectified. If we were not to carry out this investment, customers would be exposed to unacceptable safety risks or inconvenience.

8.2. Business Case Summary

The drivers described for this investment are safety, reliability and customer requirements. We are mandated to deliver this work when it emerges. However, it is useful to consider this investment through the lens of CBA.

Consistent with the NARMs methodology we have monetised the benefits of interventions and applied these to the interventions proposed. A summary of the values assigned to NARMs drivers can be found in the table below:

Option Name	PV Expenditure & Costs
Environment – GHG emissions	UK Government. Value agreed with Ofgem. • *Increases from XXXX tCO2e in 2021 to XXXX tCO2e in 2071.*
Safety – injuries and deaths	*UK Government (HSE). Value agreed with Ofgem.* • *Cost per Fatality XXXX* • *Cost per Non-Fatal injury XXXX*
Interruptions to supply – per property	*WTP research. Independently assured.* • *Range of values computed depending on duration and property type, e.g. XXXX per domestic property for up to 24 hours interruption.*
Financial impact – cost of repairs (unit)	Company accounts.
Financial impact – cost of replacement (unit)	Company accounts.

Table 23: Valuations used in economic model

CBA for non-mains related services

This section sets out the CBA of the total non-mains related services investment programme as described above. The table shows the present value of costs for each option calculated out to 2071

Option No.	Option description	PV Expenditure & Costs	PV Environment	PV Safety	PV Reliability	PV Other	Total PV	NPV
0	Reactive Only							
1	Service Relays (Chosen)		Redacted due to commercial sensitivity					
2	Service Relays exc. WTP							

Table 24: PV and NPV for scenarios

Table Notes:

- PV expenditure and costs shows the discounted sum of proactive investment (replacement or refurbishment costs), maintenance, repairs and other ongoing opex costs. Proactive investment has been considered over RIIO-2. All other financial costs are considered over the full period to 2071. All financial costs are discounted using the Spackman approach.
- PV environment shows the discounted sum of leakage and shrinkage, using the base case cost of carbon.
- PV safety shows the discounted sum of the risk of fatalities and injuries, as valued using the Ofgem stated costs per Fatality and cost per non-fatal injury.
- PV reliability shows the discounted sum of interruption risk, as valued using our own valuation research (e.g. the willingness to pay study into the cost of interruptions to homes and businesses).
- PV other shows the discounted sum of any other impacts, as valued using our research into the cost of property damage and transport disruption.
- Costs are presented as a negative value. The total PV is the summation of the five categories of costs.
- The baseline has been specified as the minimum investment position. The NPV for each option is computed as the difference between the total PV for each option and the total PV for the baseline. A positive NPV means an option has less costs associated with it relative to the baseline and is therefore cost-beneficial. The option with the highest positive NPV is the most cost-beneficial of the options considered.

The table below summarises the cost-benefit results for each option. This provides the NPV for the option (computed as the difference in total PV relative to the baseline) – to show which options are cost-beneficial or not. We also include the payback period, the RIIO-2 expenditure (replacement and refurbishment only), and the ratio of NPV to RIIO-2 to understand how much "NPV per £ spent in RIIO-2", the options generate.

Option No.	Option description	NPV - Relative to baseline	Cost beneficial	Payback Year	RIIO-2 spend (Replace, Refurb)	Ratio NPV to RIIO-2 replace/ refurb spend	RIIO-3 spend (Replace, Refurb)	Ratio NPV to RIIO-2 and RIIO-3 (Replace, Refurb)
0	Reactive Only							
1	Service Relays (Chosen)		Redacted due to commercial sensitivity					
2	Service Relays exc. WTP							

Table 25: Cost-benefit summary for all scenarios

Table Notes:

- The NPV for each option is computed as the difference between the total PV for each option and the total PV for the baseline. A positive NPV means an option has less costs associated with it relative to the baseline and is therefore cost-beneficial. The option with the highest positive NPV is the most cost-beneficial of the options considered.
- Payback shows the year when the sum of costs associated with an option is lower than that of the baseline i.e. this is the point at which the option can be considered to be cost-beneficial. This is driven by the profile of the costs and the capitalisation rate.
- The table shows the RIIO-2 proactive expenditure. If applicable the RIIO-3 proactive expenditure is also shown.
- The ratio of NPV to RIIO-2 spend shows how much NPV per £ spent in RIIO-2 the options generate. A positive figure means the investment is cost-beneficial. The higher the figure the most cost-beneficial the option is.
- We have also provided the ratio of NPV to the combined RIIO-2 and RIIO-3 spend for those options where 10 years of proactive expenditure has been considered.

In assessing these CBA results, we recognise we need to balance NPV, payback, and the ratio of NPV to proactive spend, alongside other considerations such as affordability and compliance with legal standards and obligations.

The table below shows that our preferred options to replace pipes upon failure is cost-beneficial:

	NPV	Cost benefit	Payback	RIIO2 spend	Ratio NPV to RIIO-2 and RIIO-3 (Replace, Refurb)
EoE					
LON					
NW		Redacted due to commercial sensitivity			
WM					
TOTAL					

Table 26: Cost-benefit summary for the chosen scenario by region and type

The results of the CBA show that the renewal of services on their failure is cost-beneficial.

9. Preferred Option Scope and Project Plan

9.1. Preferred Option

As discussed in Section 6: Options considered, only one feasible technical solution exists for many of the service re-lays. In many cases, these are the 'do-minimum' option (i.e. reactively replace following a fault or failure). We have chosen a proactive option for our bulk steel service re-lays, where we have a clear indication of high volumes of failures. A bulk replacement approach will enable Cadent to achieve efficiencies, where work-volumes are higher and also supports legislative compliance with PSR.

Our RIIO-2 investment plan is therefore built upon the following preferred option:

	Services re-laid after escape	Bulk Steel Service Re-lays	Re-laid service alterations	Other Services re-laid
Chosen option (only technically feasible solution)	Replace after failure	Proactively replace metallic service pipes in areas with high failure rates.	Replace after customer request	Replace after failure

Table 27: RIIO-2 preferred option.

9.2. Asset Health Spend Profile

The expenditure profile, post efficiency, is summarised below. In summary, we propose *XXXX* over the five years of RIIO-2.

Services Overall						
	2021/22	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**Total**
Bulk Steel						
Alterations		Redacted due to commercial sensitivity				
RAE						
Other						
Total						

Table 28: Proposed Total Services Expenditure in RIIO-2 by Driver

	Bulk Steel	Service Alterations	Re-laid After Escape	Other Services Re-laid	Total
EoE	1,265	3,320	16,972	18,162	**39,719**
Lon	5,920	2,635	19,438	8,718	**36,712**
NW	4,445	2,088	22,018	18,236	**46,786**
WM	685	1,400	10,997	12,191	**25,272**
Cadent	**12,315**	**9,443**	**69,425**	**57,307**	**148,489**

Table 29: Proposed Services Work Volumes by Network in RIIO-2

	Bulk Steel	Service Alterations	Re-laid After Escape	Other Services Re-laid	Total
EoE					
Lon		Redacted due to commercial sensitivity			
NW					
WM					
Cadent					

Table 30: Proposed Services Expenditure by Network in RIIO-2

We have shown this forecast expenditure as spend profile from RIIO-1 into RIIO-2.

Redacted due to commercial sensitivity

Figure 12: Forecast Non-Mains Service Replacement Investment

In summary, at the business level, our proposed capex expenditure for all service re-lays is:

Services Overall						
	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Total		Redacted due to commercial sensitivity				

Table 31: Proposed Total Services Expenditure in RIIO-2, Post Efficiency in 18/19 Price Base

We have a cost confidence of +/- 5% for this expenditure of high volume, low-cost work with a robust understanding of our unit costs.

9.3. Investment Risk Discussions

We have considered our ability to deliver the proposed workload. Given that our proposals are broadly similar on an annualised basis to those in RIIO-1, there are no expected constraints on delivery.

Reference	Risk Description	Impact	Likelihood	Mitigation /Control
09.03 - 001	Supply & Demand deliverability risk of Resource availability within the Gas industry	Potential cost increases in labour / commodity markets as demand is greater than supply	Low	Intelligent procurement and market testing. Apprenticeship and Training programmes to fill skills gaps
09.03 - 002	Stretching efficiency targets may not be deliverable (unit costs increase)	Outturn costs are not met increasing overall programme costs.	Low	Established marketplace - ability to manage the known commodity market
09.03 - 003	Unforeseen outages and failures restrict access for planned work	Programme and delivery slippage due to delay of planned outages and or site access	Low	Proactive asset management with ongoing condition surveys and response plans to prevent failures
09.03 - 004	Unseasonal weather in 'shoulder months', Autumn and Spring reduce site access/outage windows	Increased demands affecting access to sites and planned outages delay and cost increases	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.03 - 005	Legislative change - There is a risk that legislative change will impact the delivery of our work.	Potential increase in the amount of consultation and information exchange required and require us to align our plans with the safety	Med	We have established management teams to address these issues. We have also identified UMs for key areas.

Reference	Risk Description	Impact	Likelihood	Mitigation /Control
		management processes operated by 3rd Party landowner / asset owners. The potential impact is more engagement and slower delivery		
09.03 - 006	Changes to customer driven volumes	Fluctuations in work-scope affecting costs and programme	Low	RIIO-2 based upon averages over the last periods

Table 32: Risk Register

10 Regulatory Treatment

The investment set out in this paper will be covered by the NARMs methodology.

Services not associated with mains are reported in table 4.07 of the BPDT