RIIO GD2 Business Plan Appendix

Replacement Expenditure

December 2019

SGN
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Contents

1 Overview

This repex appendix sets out our historical performance and future proposals to manage the risks posed by our distribution pipe assets. The repex programme covers the replacement of existing iron mains as mandated by the Health and Safety Executive (HSE), as well as the work that is undertaken to replace corroding steel pipes, and the refurbishment or replacement of steel riser pipes suppling multi-occupancy buildings.

Our ambition for the 'repex' element of our plan has been to respond to stakeholder and customer feedback to develop a Pipe Risk Management Plan which strikes an appropriate balance between safety, network reliability, customer value and environmental impact while ensuring it can be delivered in practice, and properly considers potential future pathways for the decarbonisation of heat and transport.

We believe that our repex plan strikes this balance. At a high level, stakeholders have indicated that safety and reliability remain of high importance to them but that we should not seek to increase expenditure.

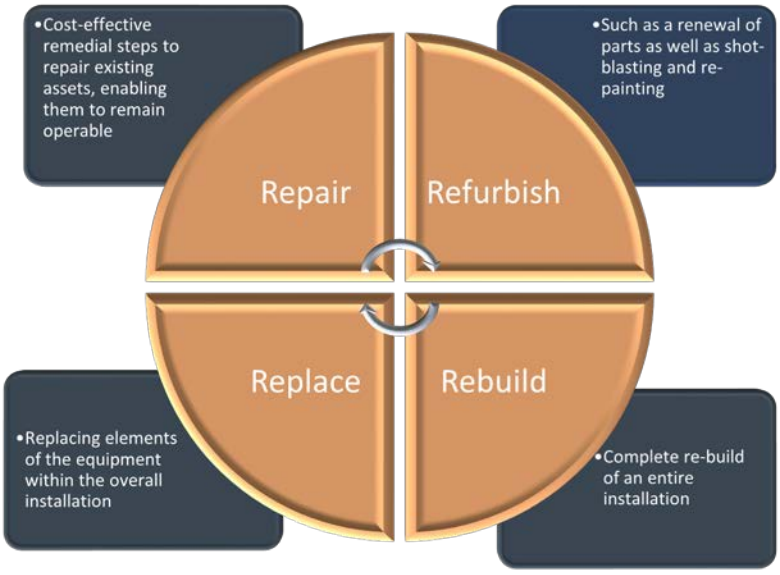
Our investment plan is consistent with expenditure in GD1 but with a change in the workload mix to reflect a changing risk profile.

In seeking to further reduce methane emissions, we have proposed a number of initiatives including an additional 200km of accelerated tier 1 iron, 160km of proactive steel pipe replacement and over 5,000 additional steel service renewals which will target hot-spot areas where failures and leakage are highest. These initiatives also improve network safety and reliability and will further reduce unplanned supply interruptions which has been forecast in our plan.

Our proposed programme of work will ensure by March 2026, the end of the GD2 control period, that 85% of our Scotland network is comprised of polyethylene and 81% in our Southern network. This will deliver a 25% reduction in pipe leakage (methane emissions) compared to our current position as well as reducing emergency repairs on our network, reducing unplanned interruptions to customer supplies and creating a network that is fit for the future in terms of potential pathways to decarbonise heat and transport.

In the last 24 months we have held a series of discussions with Operations Directors and their teams, contracting partners and our procurement team to understand the current contracting market as a means of considering the deliverability of our plan.

Throughout GD1 our approach to asset investment was determined according to our 4R strategy, designed and used to identify the most appropriate action. This strategy is based on the following interventions:



Within repex, the 4R strategy is applied through our individual asset groups, covering different approaches depending on the asset investment area in order to maintain a safe and reliable network and reduce leakage.

In most cases when applying the 4R strategy to repex, we first look at the 'Repair' option, as this is the first step in analysing the risk and integrity of a pipe. If the pipe is not fit for repair, we would look to 'Replace' and find the most safe and efficient way to do so through our thorough decision support tools and operational investigations.

Additionally, when looking at larger diameter iron pipes (tier 2 and tier 3) we can consider the 'Refurbish' strategy as an option to a proportion of these pipes that meet engineering-based qualifying criteria. Our innovative joint refurbishment technique for repex (CISBOT) allows us to successfully refurbish mains, which would have previously required full replacement, therefore expanding our means of managing risk in the network while taking cost-effective decisions.

Where repair or refurbishment are not possible or acceptable, we will undertake pipe replacement. Our approach for each pipe asset group is set out in section 6 of this appendix.

More detail on our 4R strategy and how this aligns to Ofgem's guidance options can be found in our individual Engineering Justification Papers (EJPs).

Our investments decisions in GD2 will continue to fall in line with this strategy as we continue to plan, design, install, inspect and maintain our assets in accordance with the Institute of Gas Engineers and Managers (IGEM) recommendations, other industry best practice, Pipelines Safety Regulations and the Pressure Systems Safety Regulations.

1.1 Scope of this appendix

This appendix sets out a detailed view of our past performance and our future investment plans for the risk management of our pipe assets, including but not limited to the HSE-driven Iron Mains Risk Reduction Programme (IMRRP). In line with our 4Rs strategy (Repair, Refurbish, Replace, Rebuild), our overarching aim is to continue to operate a network that is both safe and highly reliable, consistent with clear feedback from our stakeholders that these are both a high priority which is expected and delivered as the norm.

In developing our forward plans, we have considered the necessity of ensuring our network operates safely in the 'here and now' by managing the risk of these ageing assets while also recognising that a degree of uncertainty over the future role of the gas network will remain until policy becomes clearer in terms of the various pathways to decarbonisation in the UK.

1.2 Impact

Metallic mains, in particular iron mains, are deteriorating at an increasing rate. The deterioration of a main often results in a gas leak or mains failure, and in some cases the leak or failure will occur more than once in several locations on the main. Pipe risk management through mains replacement focuses on replacing deteriorating metallic mains with new polyethylene (PE) pipe, which is statistically proven to be more reliable, in order to reduce the risk of failure and maintain a safe network. When replacing mains, the services associated with the mains will also be replaced with polyethylene.

2 Repex within the business plan

The repex appendix provides an explanation of the main points of investment which have been undertaken in GD1 and are expected to be undertaken in GD2.

Over the course of GD2, repex expenditure is expected to be approximately 44% of total expenditure and as such has its own activity line.

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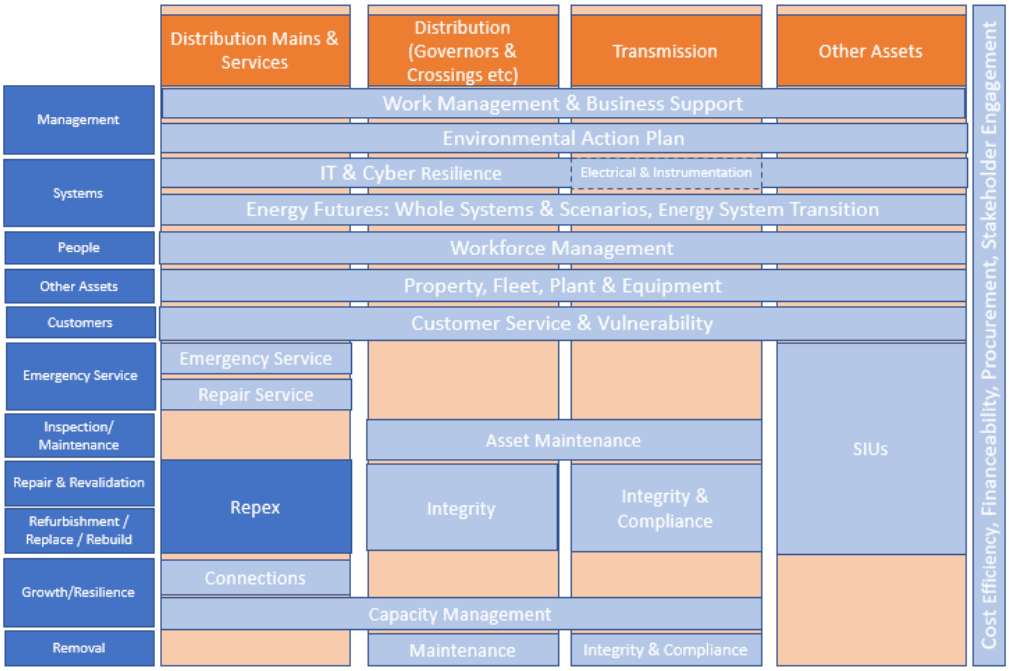
Figure 1. Appendix Structure



Related appendices

repex, being the largest area of work in the network, has an impact on several of the other business areas, as shown in table 1 below.

Table 1: Interactions table

Title	Comments – how these relate to repex
Emergency services	Because our pipes begin to fail more frequently as they deteriorate, the public are reporting smells of gas (public reported escapes), therefore the emergency call centre will be contacted and one of our first call operatives will attend the site to handle the situation. This is the first indication that a pipe may be due for replacement as the more failures that are reported on a pipe, the higher the risk score will be, which then gives an indication of a pipe's integrity.
Repair	Where our emergency teams have identified that the gas escape is a result of a failure on a pipe, they will then pass the job to our expert repair team to locate the failure and carry out repair work, whether that is on the service pipe, mains pipe or on a riser. Our repex strategy positively impacts our repair workloads, as the more replacement work we carry out, the less frequent repair works become, as we lay new PE in the pipe to replace the deteriorating iron/steel pipes.
Connections	When a customer requests an alteration to their service we sometimes discover the existing pipe to be steel which we must renew rather than alter. HSE deem this to be a mandatory requirement.
Customers and Vulnerability Plan	As a result of the mains replacement programme we transfer existing PE services to the new PE main and renew old metallic steel services as part of a replacement project. To do so, a customer's supply will be temporarily interrupted until the work is complete, at which point we will reconnect their supply. This is known as a planned interruption, during which we work with our customers to ensure they are aware of the timing and duration, and also to establish how best to support any additional needs they may have.
Workforce Management	We have a range of contractors working on our repex programme in both Southern and Scotland, with the former involving a relatively higher contractor ratio due to the more dense population of pipes. We also utilise our own SGN workforce to work on mains replacement, particularly in the summer months when we have more internal resource available as we see fewer gas leaks coming in while the temperatures are warmer. This flexibility allows us to proactively manage our work programme, supplementing contract labour with direct labour and making effective use of their time.
Innovation	We have successfully developed and implemented a range of innovative techniques in GD1 in support of our repex programme, and we have an ambition to continue driving further developments to improve productivity in GD2.
Environmental Action Plan	As we replace metallic pipes and install PE, we reduce the likelihood and occurrence of leaks, and as such are significantly reducing the amount of methane released into the atmosphere through leakage. This creates a great environmental benefit by reducing shrinkage, which is the largest driver of our overall carbon footprint.

There are some common themes across all the different workstreams within SGN as listed above, many of which will be drawn out in our EJPs including; the safety benefit in terms of risk, the environmental benefit in terms of leakage reduction, opex benefits in terms of reducing operating cost of the network as we are reducing the number of emergency call outs and repairs, and lastly, in doing all of those things we are increasing the overall reliability of the network.

Our EJPs discuss these themes, with specific details being covered in the relevant individual appendix. For details of the repex options considered and the cost benefit around these themes, please refer to section 6.5 of this appendix.

Throughout GD1, SGN developed the following strategy to reduce shrinkage, employing a combination of the repex programme, wider industry collaboration and investment in pressure management and monoethylene glycol (MEG) projects. MEG is used inside the pipes to reduce leakage through old lead yarn joints in iron pipes. During GD2 we will continue this journey and are proposing an acceleration of the repex programme to reduce leakage faster as well as deploying innovation.

Figure 2. Reducing shrinkage strategy

3 GD1 performance and learning

3.1 Overview of service delivered

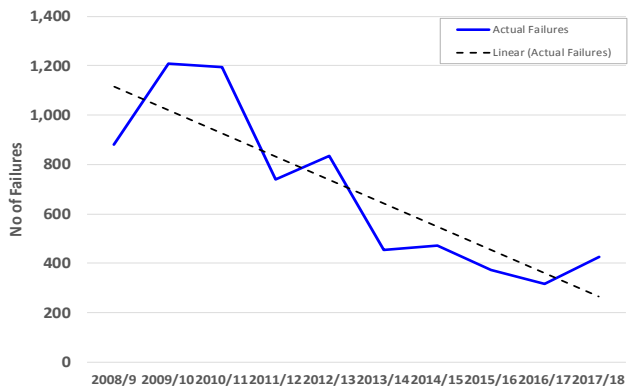
In our GD1 Business Plan, we set out a series of objectives that we intended to deliver against, to meet our customers' needs. In some instances, these objectives changed as we moved from the initial proposals though to agreed deliverables. However, in most instances we have delivered over-and-above the stated objectives as well as responding to our stakeholders' feedback. Through this section we will describe different aspects and outputs of our repex programme that we believe contributed to our positive performance through GD1, and how this sets us up to continue our excellent performance in GD2.

Predictive analytics

We have historically had a strong process in place for prioritising pipes within our programme based upon risk and condition. Prior to GD1, SGN was the first company to undertake a comprehensive Predictive Analytics (PA) project, utilising five years of pipe failure data and concentrating on iron pipes, to understand past and future performance. This project demonstrated a very clear link between pipe failures and cold weather events, a challenge set by Ofgem in the GD1 final proposals. The outcomes of this project have been presented to industry, the HSE and Ofgem on several occasions. The project was repeated in January 2019 adding a further five years of data and extending analysis by three further cohorts of steel mains. By using PA, we are able to identify candidate pipes for replacement which typically have a higher failure rate. By prioritising these pipes, their replacement makes the most significant positive impact to the reliability of our network (demonstrated through reduced emergency services and repair workloads), in addition to a reduction in leakage.

The charts (figures 3a,b and 4a,b) below show the reduction in actual fractures and corrosions achieved in GD1 for both Scotland and Southern from 2008/09 to 2017/18. The peaks in the charts below demonstrate how harsh weather has impacted our networks' failure rates. As demonstrated by the reducing trend, we have delivered a material reduction in our failure rates and attribute our success to our robust selection process using PA for mains replacement.

Figure 3. (a)Scotland: number of failures



(b) Scotland: failures per km

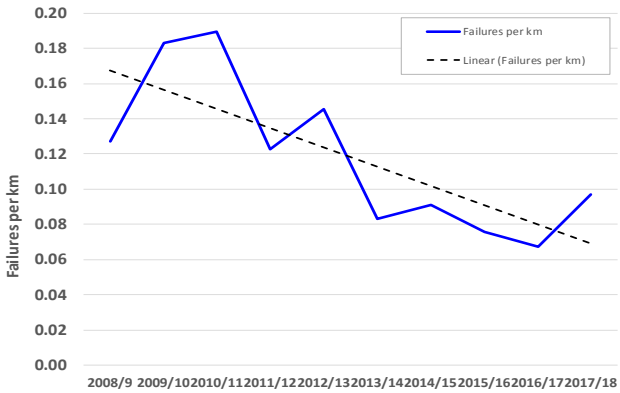
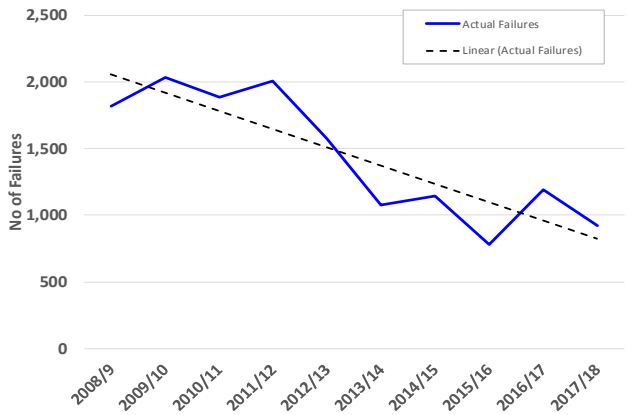
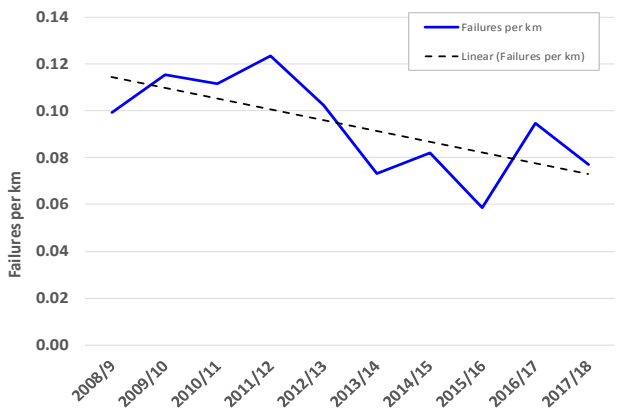


Figure 4. (a) Southern: number of failures



(b) Southern: failures per km



Gas in buildings

One of the challenging secondary deliverable outputs of GD1 is Gas in Buildings (GIBs), when gas leaking from a failed pipe finds a route into a building and there is a potential for it to accumulate to the point where it could reach a dangerous limit and create the risk of a gas explosion. This is highly unpredictable and difficult to quantify through targets, given that it is very sensitive to changes in cold weather that impacts the ground conditions through which the gas is leaking. As with pipe failures, this was addressed through our second data analytics project, a platform called hypercube which was developed in July 2018 to work specifically on GIBs which will help to prioritise higher risk replacement programmes.

Riser overview

A riser is typically an arrangement of above ground, horizontal and vertical steel pipes providing gas to a multi-occupancy building greater than two floors in height. Examples of risers can be found in figure 5 below.

Figure 5. Riser examples

Newly installed steel riser pipe incorporating expansion pieces on the individual laterals leading to each flat.

Newly installed steel riser pipe on the external face of the building with individual laterals leading to each flat.

SGN was the first network to introduce specific management procedures and a risk model for these pipes in 2008. This was driven by our need to develop a specific asset management approach that reflected the higher consequences of a failure leading to a gas explosion. Due to the large number of multi-occupancy buildings in our network, particularly within London, we accelerated our replacement investment in these assets from 2008/09. This investment has continued throughout GD1 and, in the light of the increased safety focus on high rise properties, we propose a continuation of this programme in GD2.

The population of gas risers supplying high rise (six storeys and above) and medium rise (three to five storeys) buildings is currently 11,588 in Southern and 5,593 in Scotland. As part of our ongoing inspection and risk assessment programme of these assets, we identify any pipework that is at or nearing end of life, or where there are other risks giving cause for concern. Our management procedure (SGN/PM/REP/3) and riser risk model (RRM) have been developed in conjunction with a third-party technical services consultancy. These allow us to risk score the risers accordingly and to take a prioritised risk-based approach to the interventions we plan. This tool is unique to SGN and was the first type of riser risk model to be developed within the gas industry. It has been fully embedded within SGN and aligned to our investment and intervention strategy for almost 10 years.

In recent years there has been a greater public interest on gas supplies to high rise buildings. With additional enquiries and requests for safety visits being received from external stakeholders, we have responded quickly and professionally, to satisfy any concerns and reassure stakeholders that the gas pipework is safe. We continue to monitor and replace as necessary following our risk-based approach. We are also working closely with local authorities as well as other agencies and stakeholders to alleviate any concerns and support the risk management processes.

Due to ongoing reviews, there is some uncertainty about any decisions which may affect the industry and what change may come as part of changes to building or fire regulations. It is likely there will be more focus on buildings of 10 storeys or more which have been defined as higher risk residential buildings. This will require further stakeholder liaison with building duty holders around the installations, including details of any safety and isolation devices as well as details of our ongoing inspection regime.

Mains risk prioritisation system

All iron distribution mains, and steel distribution mains (= >3") operating up to 2.0bar pressure are subjected to an individual detailed pipe risk assessment to determine the current condition of the main, and to establish how this presents a risk of failure leading to a gas explosion. From this, an industry wide Mains Risk Prioritisation System (MRPS) model, recognised by the HSE, is used to calculate the risk score for each pipe. This tool has proven to be very successful through GD1 in reducing and monitoring risk in the network as shown in our risk reduction performance as set out in section 3.3 above.

MRPS is a system that is owned and operated by DNV GL on behalf of the gas distribution networks, developed between 1997 and 1999 and implemented by Transco in 2000. The system allocates a 'Risk Value' to each individual pipe based upon analysis of historical pipe failure data and pipe location information gathered from a site survey.

MRPS is utilised as a risk-based decision support tool, which is used to identify individual distribution mains for replacement, based upon prevailing gas policy for GDNs at any given time. The system uses historical pipe performance data such as fractures, corrosion and joint failures as well as data collected from an on-site survey i.e. proximity to property, presence of cellars, etc. As the integrity of these pipes deteriorates over time, the risk score for any given pipe can dynamically increase as new failure data becomes available. This may also be the case where the survey data is updated e.g. a new property built adjacent to existing iron pipe.

The risk score for a pipe is expressed in terms of incidents per km per year. The score represents the likelihood of an incident arising from a failure of that pipe where leaking gas has entered a property and ignited leading to an

explosion that results in one or more fatalities, serious injuries and/or major structural damage. The higher the score, the higher the risk. Where a pipe is located within 30m of property, it has a positive risk score. For pipes greater than 30m from property, the risk model allocates a zero-risk score. This distinction enables us to identify those iron pipes that are subject to the HSE IMRRP and therefore are already scheduled for replacement.

In both the iron and steel populations, most pipes are in the risk score range of 0 to 30 and the 30 to 60 range as shown in table 2. In Southern these ranges account for 9,994km (69%) and 1,466km (10%) respectively. In Scotland they account for 3,578km (65%) and 594km (11%) respectively. Thus, the population is generally approaching a point where it can be considered broadly homogeneous in that all the remaining pipes have a broadly similar level of risk where any one of them has the potential to fail leading to a gas explosion. The implication is that the flexibility we agreed with the HSE remains appropriate and we will continue to use PA to optimise pipe selection.

The individual risk score for each pipe multiplied by its length represents the calculated likelihood of an incident expressed in terms of incidents per annum x 10^9. Thus, the sum of risk for all of these pipes gives a total risk of 0.45 incidents per annum in Southern and 0.13 in Scotland.

Table 2: Total risk for iron and steel

	Southern			Scotland		
Risk Band	**Steel**	**Iron**	**Total**	**Steel**	**Iron**	**Total**
-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0-30	0.0100	0.1012	0.1112	0.0025	0.0309	0.0334
30-60	0.0089	0.0523	0.0612	0.0024	0.0230	0.0254
60-90	0.0133	0.0321	0.0453	0.0024	0.0132	0.0156
90-120	0.0098	0.0184	0.0282	0.0019	0.0070	0.0089
120-150	0.0052	0.0095	0.0147	0.0015	0.0036	0.0051
150-180	0.0054	0.0076	0.0130	0.0012	0.0025	0.0036
180-210	0.0049	0.0057	0.0106	0.0013	0.0016	0.0029
210-240	0.0039	0.0046	0.0084	0.0011	0.0020	0.0031
240-270	0.0045	0.0038	0.0083	0.0014	0.0014	0.0028
270-300	0.0026	0.0026	0.0052	0.0018	0.0003	0.0021
300-330	0.0033	0.0025	0.0058	0.0010	0.0007	0.0018
>330	0.1145	0.0285	0.1430	0.0254	0.0033	0.0287
Total	**0.1863**	**0.2686**	**0.4549**	**0.0439**	**0.0895**	**0.1334**

Note: Each pipe is allocated to a risk band depending upon its risk score. A pipe with a risk score of 30 has a likelihood of incident risk score of 30 x 10^6 incidents per km per annum

Thus, the risk in Southern arising from the iron mains population is calculated to be 0.27 incidents per annum, and from the steel mains population 0.19 incidents per annum, giving a combined risk of 0.45 incidents per annum. For Scotland risk arising from the iron mains population is calculated to be 0.09 incidents per annum, and from the steel mains population 0.04 incidents per annum, giving a combined risk of 0.13 incidents per annum.

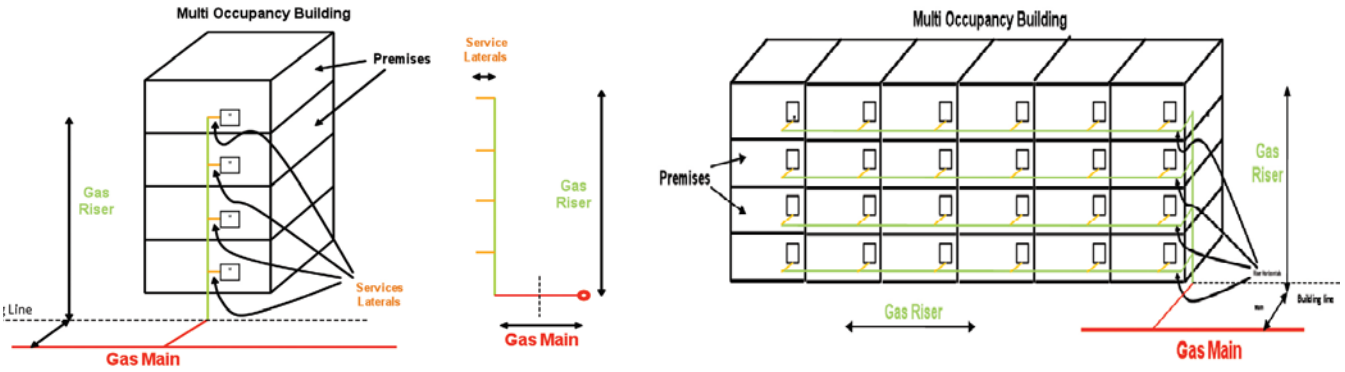
Gas risers supplying multi-occupancy buildings

We have a large number of gas supplies to high rise and medium-rise multi-occupancy buildings (MOBs). These are usually constructed of steel; however, through our ongoing survey programme, we have identified a number of risers constructed of lead and copper. These risers are commonly found to be installed internally within high rise properties, typically during construction, and buildings will contain one or more risers. Riser interventions are usually driven by an emergency service visit due to the smell of gas being reported, or in the course of undertaking mains replacement activities.

A gas riser is defined as a pipe connected from a gas main (the delineation being at the building line of the property), supplying (or with the potential to supply) more than two supply meter installations. In the situation where such a pipe is classed as a riser, it will be classed as such over its full length with only the sections of pipe teed off the riser to each individual supply meter installation being classed as service lateral. In terms of regulatory reporting, gas risers are sub divided by building (riser) height into three categories, <=20m, 20m to <=40m and >40m.

Figure 6 (a) below illustrates a four-storey building with external riser pipework. In this example, the section of pipe running perpendicular from the gas main in the street to the building line of the property is classified as a gas main. The pipe running vertically from the end of the gas main/property line to the highest point is classified as a riser, and the section teed off the riser to each meter is a service lateral, as illustrated by figure 6 (b).

Figure 6. (a) Riser on external face **(b) Internal laterals and risers**



In Southern we operate 11,588 gas risers and in Scotland 5,593 gas risers supplying multi-storey premises. This riser system is broken down into three building (riser) height categories as in the following table 3.

Table 3: Riser population of Southern and Scotland (March 2019)

Riser Length	Southern	Scotland
<20m	8,456	5,200
20 to 40m	2,751	135
>40m	381	258
Total	**11,588**	**5,593**

Riser replacement

We started our riser replacement programme in 2009. During GD1, we were the first network to have a management procedure specifically based on risers and the first network to prioritise work on risers on a risk basis, leading to a significant amount of riser replacement work along with some refurbishment work. This is largely due to the introduction of the SGN Riser Risk Model (RRM) in the years just prior to GD1 and by having a method to assess risk as well as prioritise proactive replacement of risers based on risk rather than reactive replacement on failure of the asset.

The RRM is designed to incorporate a wide range of factors that could contribute to the consequences of a failure of a gas riser. It considers the risk associated with the material, length and condition of pipework as well as other influencing factors which could compromise the integrity of the assets and associated risk such as the environment, ventilation, and the population of the building, including whether they may be vulnerable customers. We have a detailed inspection regime associated with the RRM which allows us to update these factors when necessary and monitor any changes or deterioration that could increase the risk and subsequent prioritisation for intervention.

Our proactive approach to the risk management of risers has enabled a switch from unplanned to planned replacement, meaning that fewer customers have had their supplies interrupted for an extended period of time, i.e. greater than 24 hours. This has been achieved through the introduction of a range of new innovative techniques, which are detailed in our innovation riser section and funded through the Network Innovation Allowance (NIA) mechanism, enabling us to safely undertake repairs to the pipe while maintaining gas supplies to our customers.

Our approach to risers varies according to region. In Southern we have a high number of gas risers and therefore have a dedicated Operations team set up to deliver the significant workload involved. This has allowed SGN to dedicate specific project managers working alongside contractors carrying out the operational work and to ensure that the work is planned efficiently, including a high level of stakeholder engagement with both building owners and residents.

In Scotland the workload is considerably lower and would not justify a dedicated operational team. As such, the work is carried out by direct labour alongside their mains replacement activities. Our operations managers are responsible for ensuring that work is planned efficiently, and that it includes the same high level of engagement seen in Southern.

By using the RRM and working more proactively we can forward plan riser replacement work, which will carry forward into GD2. This also ties in with early engagement with stakeholders, including local authorities, so that we can co-operate with any work they may also be carrying out on their buildings.

Stakeholders have raised queries about the future of gas in high rise buildings. Although there is some uncertainty in the supplies to high rise or multi occupancy buildings, we have a duty to comply with current licence

obligations and legislation to ensure we continue to provide a safe and reliable gas supply to customers. In addition, stopping or slowing down the interventions which we currently undertake could put the integrity of the network at risk and increase the likelihood of asset failure.

Although removing gas from high rise buildings could be an option, we do not believe this to be generally the best approach for the customer. The residents of these buildings are often some of the most vulnerable and fuel poor in society and to remove the option for them to have a gas supply could lead to further problems when comparing the high cost of electric heating to using gas. It is understood that some local authorities have plans to demolish many of their high-rise building stock in the medium to long term future, however, we are still obliged to provide a safe and reliable gas supply to customers and we must continue to do so until there is no longer a need. If we identify pipework which is of poor integrity and requires intervention under our risk-based system, then we cannot leave that pipework to continue to operate until the future of the building is decided.

MOBs record keeping

During GD1 we have undertaken a comprehensive review of our riser records, systems and associated processes. We took a wide group of people from across the business including Network, Operations, Policy, Training and IT, and set up specific workstreams to look at each of these areas.

We have carried out reviews of policy documents and work instructions and updated these where necessary, but this will continue in line with the current review of IGEM standard IGEM/G/5. Alongside this we have updated training requirements and material for those involved in installation and survey of riser assets to further enhance their knowledge and ability to capture information and to do so consistently.

We have also carried out a detailed review of our riser risk model in conjunction with our technical services consultancy. This includes capture of additional safety related data as well as a slight change to our methodology and the data score weightings for calculating the risk associated with each riser asset which allows us to take a prioritised approach to interventions.

Business processes have been reviewed and updated or developed to ensure ownership and consistency, plus internal reports have been further enhanced or newly developed to give better visibility of key data or trends relating to these assets. This includes newly defined process safety measures that have been introduced following a detailed bow tie analysis of this asset group. These measures will allow us to monitor trends or identify any areas at risk.

In addition, we undertake much more internal audit of the data, both from a desktop perspective as well as on site survey audits, to give us further assurance on the data quality.

There is also our ongoing review of records in relation to high rise buildings and in 2018 we procured the latest available building data sets which were analysed in relation to our existing records and then surveys carried out accordingly. The latest building data sets have also been analysed for the medium rise buildings (three to five stories), which we have started to survey and capture during GD1 and will continue on into GD2, as detailed in our Asset Maintenance appendix (016).

We are continuing to investigate future system improvements, including further ability for digital capture in the field and it is anticipated that by the end of GD2 we will have a fully mobile solution across our work management systems which will drive efficiencies as well as greater and quicker visibility of data. As part of this we will also look to enhance the analytics of this data to allow us to continue making the most appropriate investment decisions.

Since late 2018 we have had ongoing engagement with the HSE as part of their MOB high rise inspections being carried out across all GDNs. As part of these inspections we have satisfied them that our policies, processes and management systems are effectively managing the MOB records. We have also discussed with them in detail our

operational processes and practices, which included site visits of inspected risers as well as recently replaced risers and this gave assurance that our procedures are adequately carried out. As part of the discussions during these inspections it was identified there was a need for a process and system to be in place for recording stakeholder engagement carried out where any issues with the building are identified. This process and associated system have recently been implemented and ensure that we are notifying building owners or duty holders where an issue has been identified and what steps may be taken to resolve any issues.

We have also increased our engagement with relevant stakeholders including local authorities, housing associations and private residents' associations. We have engaged with them as part of our review of building data and face-to-face meetings have been held with some stakeholders to discuss some of the specific requirements or some of the challenges we both have. We also carry out early engagement wherever possible to discuss future interventions to ensure that we have agreement for our plans as early as possible in the planning process and to minimise any disruption for the individual customers and other residents.

We have also previously engaged with other GDNs to discuss how we manage these assets from both a Network Management perspective covering policies, procedures and systems as well as an Operations perspective in terms of managing proactive replacement activities or dealing with reactive situations. We will continue to have this type of engagement and information sharing as opportunities arise.

3.2 Legislative background

Earlier in this appendix we referenced the importance of maintaining the pipeline network in efficient working order and in good repair. This is set out as an absolute duty in law in Regulation 13 of the Pipelines Safety Regulations (PSR, 1996) and we will continue to comply with this duty through GD2. This duty applies equally to all pipes that we operate.

We will also comply with the HSE Iron Mains Risk Reduction Policy that requires all iron pipes <=8" diameter and within 30m of a property to be decommissioned by March 2032. With our progress through GD1 and our forecast workload for GD2 and GD3, we are confident that this target is achievable.

We also have a licence obligation to ensure that our systems are designed and operated to ensure security and reliability of supply to all of our 5.9 million customers during the most severe of winter conditions when gas demands typically reach peak levels.

The primary legislative framework encompassing pipe risk management activities that will continue to be followed through GD2 are:

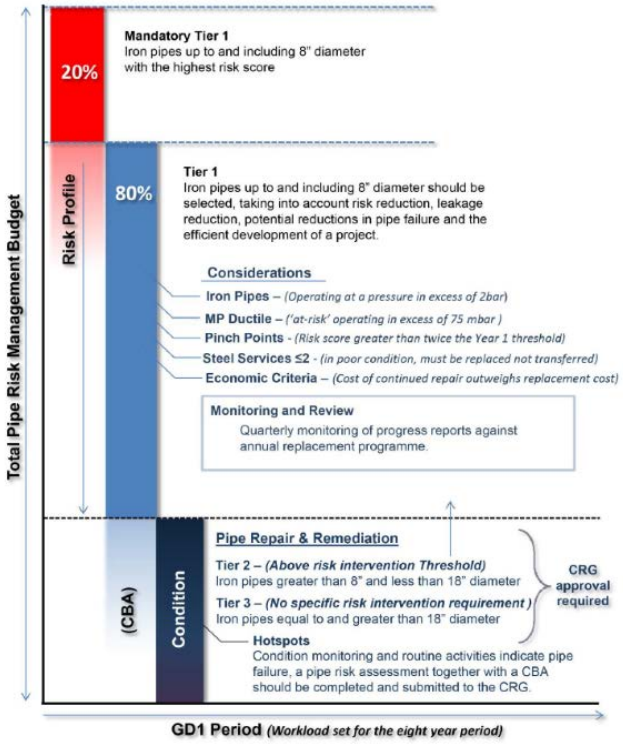
- Health and Safety at Work Act 1974 (our duty of care);
- Gas Act 1986;
- Gas Safety (Management) Regulations 1996 (requiring us to have an HSE approved Safety Case);
- Pipeline Safety Regulations 1996 (pipe risk management, linked to HSE IMRRP Enforcement Policy);
- Pipeline Safety (Amendment) Regulations 2003 (sets out requirement for an approved programme);
- Environmental Protection Act 1990 Traffic Management Act (2004); and
- Transport (Scotland) Act 2005.

3.3 Output delivery

Prior to the current GD1 price control period, all iron pipes within 30m of a property were deemed to be mandatory for decommissioning by 2032. The 30m was a length that was deemed by the HSE to be a safe distance for the gas to disperse into the atmosphere before it reached and entered a property and could ignite, causing a danger to life. In 2012 the HSE issued a new enforcement policy for iron mains (the IMRRP) that split the iron population into three discrete tiers sub divided by diameter as follows:

- Tier 1 up to and including 8”
- Tier 2 greater than 8” and less than 18”
- Tier 3 greater than or equal to 18”

Figure 7. Replacement categories



Tier 1 pipes are mandatory pipes which require decommissioning by March 2032. Tier 2 pipes and tier 3 pipes no longer have a mandatory requirement for decommissioning by 2032 and any work proposed requires supporting with an engineering justification and cost benefit analysis (CBA). This is set out within the HSE enforcement policy.[1]

Through extensive stakeholder engagement with the HSE we agreed an approach unique to SGN, where we had greater flexibility over the selection of pipes over the GD1 eight-year period (rather than annually). Figure 7 shows how this was set out by splitting our mains through all the tier levels into three categories:

- 20% mandatory workload
- 80% non-mandatory workload to be monitored and reviewed
- Allowance for CBA driven mains replacement

The benefit of this flexibility is that we are less constrained when working with local authorities, stakeholders and customers and where possible we can bring several projects together to create a single larger project. This is beneficial for our customers as it creates less impact and disruption as the work is done in a shorter time; and also creates benefit due to lower mobilisation costs, where our contractors can stay in one place for a longer period of time.

We are targeting the higher risk pipes in the network for removal, while monitoring the mains that still have an element of safety driven replacement but are lower risk.

1 http://www.hse.gov.uk/gas/supply/mainsreplacement/enforcement-policy-2013-2021.htm

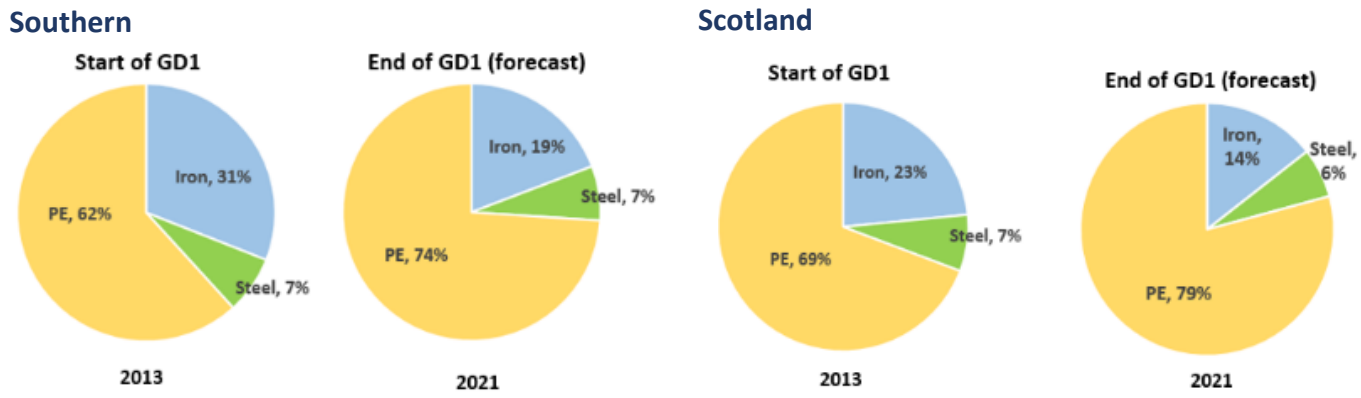
Mains and service replacement

In the past we have delivered against targets set by the HSE and Ofgem, helping us to maintain a safe and reliable network. As seen in figure 8 below, we are forecast to deliver a 74% PE network in Southern and 79% PE network in Scotland by the end of GD1, with the remaining population being mainly iron pipes and a small percentage of steel, which we will continue to replace as we move into GD2.

At a recent stakeholder event in reference to our repex GD2 proposals one stakeholder elaborated:
"I think you have it about right. Based on GD1 you have achieved outputs. Customers are happy. Shareholders are happy. Gas and water networks have some serious unknowns of climate change and Brexit – these could have considerable effect but as it stands you are along the right lines"

Distribution mains populations and risk profiles

Figure 8. % of PE mains in gas network at start and end of GD1



Iron mains risk reduction

In GD1 we were targeted to reduce our safety risk on our iron mains network by 34% in our Southern network and 28% in our Scotland network. By the end of GD1 we forecast to have outperformed this target and to have reduced our safety risk by 49% in Southern and 51% in Scotland as shown in figure 9 and figure 10 below, where the vertical axis is showing the year on year reduction in the risk of an incident. The significant reduction in safety risk has been achieved largely due to the flexible iron mains risk reduction strategy we have adopted, as discussed above.

Figure 9. Scotland iron mains safety risk

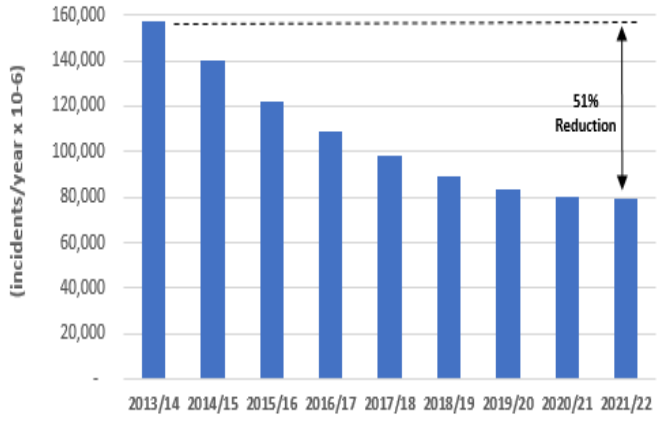
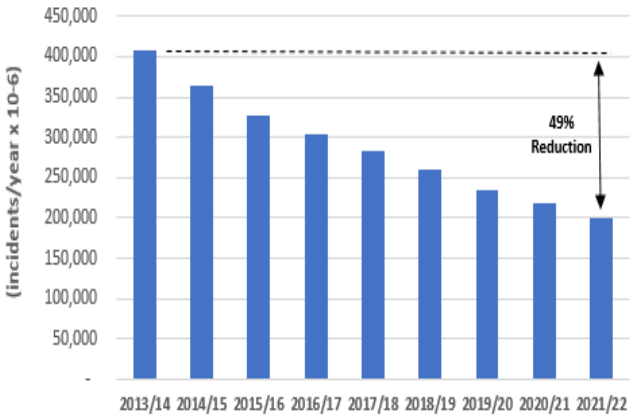


Figure 10. Southern iron mains safety risk



We have transformed our design process, from 60% by mains insertion in Southern and 48% mains insertion in Scotland prior to the start of GD1 to our current levels, exceeding 91% by mains insertion in Southern and 85% by mains insertion in Scotland. By increasing insertion this has reduced the amount of new pipe replaced using conventional open cut trenching techniques and this has delivered significant benefits in terms of increasing productivity, creating a reduction in the cost of delivery and reduced impact and disruption to the highway and highway users (with shorter notice periods required). Insertion also allows us to reduce the number of excavations, which has reduced spoil to land fill and hence our environmental impact by digging fewer holes in the ground and creating less waste as a result. Fewer open excavations and reinstatement also means that we create a safer environment for road users and members of the public.

In GD1 we have also adopted live insertion techniques. This has allowed us to deliver an element of pipe insertion without interrupting the gas supply. Live insertion has the benefit of allowing us to reduce the number of times our customers are interrupted during works as well as the duration of time they are off gas while we renew the service pipe to their property. This also allows us to be more accommodating to customers' needs and arrange when the interruption to their supply will take place, rather than the usual interruptions they would face with conventional replacement, therefore enabling a better customer outcome. Since the start of GD1, for those mains we insert, we have seen live insertion increase from 20% to 32% in Scotland and from 12% to 57% in Southern.

Throughout GD1 we have clearly demonstrated our commitment to continued risk reduction and maintaining a safe and reliable network. We are currently forecasting to close out GD1 by exceeding our 'Risk Removed' primary output and fully achieving our Ofgem 'Length Off Risk' secondary deliverable target, leaving us in a positive starting position for the start of GD2.

In GD1 we have had great success in planning our mains replacement programme to allow us to reach our targets and maintain a safe and reliable network. In GD2 we will continue to effectively plan the repex programme through careful pipe selection and risk prioritisation.

At present, we provide our high-level plans to local authorities over a five-year window, with detailed plans available up to 18 months in advance. Following clear feedback from a wide range of stakeholder events, it is our intention to undertake more detailed project planning over an extended time horizon, potentially through to the end of the GD2 period, ensuring these plans are discussed with relevant authorities at the earliest opportunity.

We are currently two thirds of the way through the 30-year metallic iron mains replacement programme, which begun in 2002. A large proportion of the higher 'at-risk' (within 30m of a property) iron mains in this programme has now been decommissioned and replaced, which allows alternative replacement approaches to be considered in GD2. These include:

- Larger project lengths and improved visibility for contractors
- Larger scale site operations with dedicated supervision
- Better co-ordination with other utilities and agencies
- Potential to reduce environmental impacts and reduce mobilisation costs

Newly laid replacement mains

Where we are laying new pipe, we are putting PE mains in the ground to carry gas safely through the network. In almost all circumstances, a replacement PE main will be laid to replace the metallic main we abandon. Abandoning a main means that we are safely decommissioning it, so it is no longer in service.

Historically it has been possible to lay less new mains than the length being abandoned, usually through efficient planning – for example the replacement of two parallel mains with a single new main. The ratio between abandonment and lay is known as the 'abandonment ratio'. The historical ratio for GD1 was on average Southern-1.05 to 1.00 for tier 1 iron mains and Scotland 1.02 to 1.00 for tier 1 iron. In GD2 we will continue to reduce lay lengths whenever possible, aiming for a ratio similar to that of GD1, with Southern 1.02 to 1.00, and Scotland 1.06 to 1.00.

Our design process seeks to maximise opportunities for mains insertion as this methodology significantly reduces road congestion. However, this approach does lead to a lower abandonment ratio. This is due to the fact that using insertion on dual mains, although more productive and less disruptive, results in more pipe being laid than if we were to replace dual mains with a single new polyethylene main using conventional open cut techniques. We will optimise our designs by looking for opportunities to maximise the use of mains insertion techniques. However, to achieve this we may need to increase operating pressures to compensate for the use of smaller diameter replacement mains, which have less capacity available.

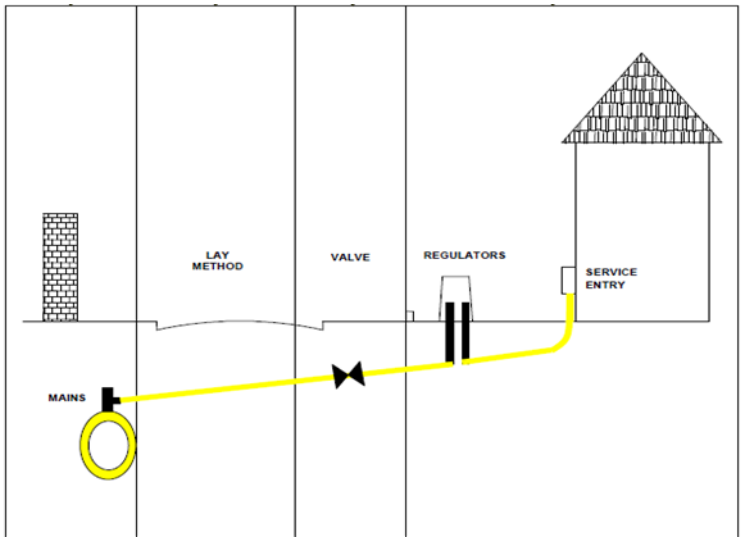
Future mains lay lengths have been developed based on an extrapolation of historical data. Typically, the new mains we lay will be smaller diameter than the mains being decommissioned as opportunities for the use of insertion techniques are maximised through efficient design. In GD1 we have already indicated the improvement in insertion rates from pre GD1 levels, which drives improved productivity, and we will continue in this vein in GD2. For example, being able to replace 4" iron mains with 90mm PE enables us to use insertion methods, reducing the amount of customer interruptions.

When designing mains replacement schemes, the most efficient design may identify an opportunity to lay pipes of a greater diameter than those being decommissioned, referred to as 'upsizing' and 'capitalised replacement'. This may be an appropriate strategy where the requirement for network reinforcement has been identified and can be avoided by incorporating into the mains replacement scheme. While this creates a small marginal increase in immediate cost, it avoids the need for a separate reinforcement project, and is therefore more cost-efficient in the long-term. In other instances, this upsizing creates additional upstream capacity which then allows increased levels of pipe insertion in the downstream network offering a more efficient and holistic solution.

Service pipes

A service pipe is a pipe for supplying gas to premises from a distribution main, being any pipe between a distribution main and the outlet of an Emergency Control Valve (ECV).

Figure 11. Service pipe and its different components



We supply our customers through service pipes constructed of either polyethylene and/or steel. Many of the steel services are replaced each year alongside the mains decommissioning programme. Others are replaced during repair and planned service pipe alteration activities. A proportion of these pipes supply high rise and low rise (tenement style) multi-occupancy buildings.

Figure 11 shows a service pipe and the different components it may include on the way to the meter point of a property.

Depending on the size, material and pressure of the service pipe it may require a valve or regulator to be installed before it reaches the meter point. This is typically required when the pipe is 2" or greater diameter or medium pressure and above.

Delivery

In GD2 we will continue to manage our operational functions through local depots, close to the customers that we serve in those areas, using our local knowledge of the communities in which we are working and effectively utilising tailored project delivery through our local contacts. This relatively de-centralised, autonomous approach is a strategy which is discussed further in the Work Management and Business Support appendix, and one which we believe this is a contributory factor to the high customer satisfaction scores we achieve.

We have also been flexible in our depot structures by amending boundaries to respond to changes in the delivery of our programme, ensuing we deliver our required outputs across our whole network. During GD1 we introduced a dedicated major works team to focus on tier 3 and CISBOT, enabling our more complex works to be delivered by a specialist team.

Our resource strategy in Scotland is to utilise a balance of our own direct labour supported by contractor resources, while in Southern we primarily maintain the use of contractor resource with our direct workforce supporting in the summer months.

Our Southern resource strategy will continue to predominately use contractor resource; however, it has become more challenging to attract resource due to a national shortage of skilled teams. Working in London and the South also comes with additional costs which has increased our contract rates as we have to attract contractors from all over the country. We will therefore be looking to create more direct labour (DL) teams to deliver work all year-round, accounting for 10% of the overall length per year (currently less than 1%). We will also continue to use DL teams through the summer months and transfer additional resources to repex should repair workload reduce, supported by a programme to upskill and train new and existing staff. This will give us greater control and help to de-risk delivery by reducing our reliance on contractor resources.

This approach will support productivity improvements (plus customer and environmental benefits) while maintaining a programme that remains practicable and can be safely and efficiently delivered.

3.4 Customer experience

In delivering this work we have ensured that our stakeholders are fully engaged in the planning process and our works are planned to minimise disruption as far as is possible. Our performance has consistently been positive and in the past year we have seen Scotland ranked first of eight networks with a score of 8.97 for planned works, and Southern ranked third with a score of 8.76 for planned works. We have also seen a great reduction in the number of customer complaints over the last two years as we continue to develop our programme for delivery.

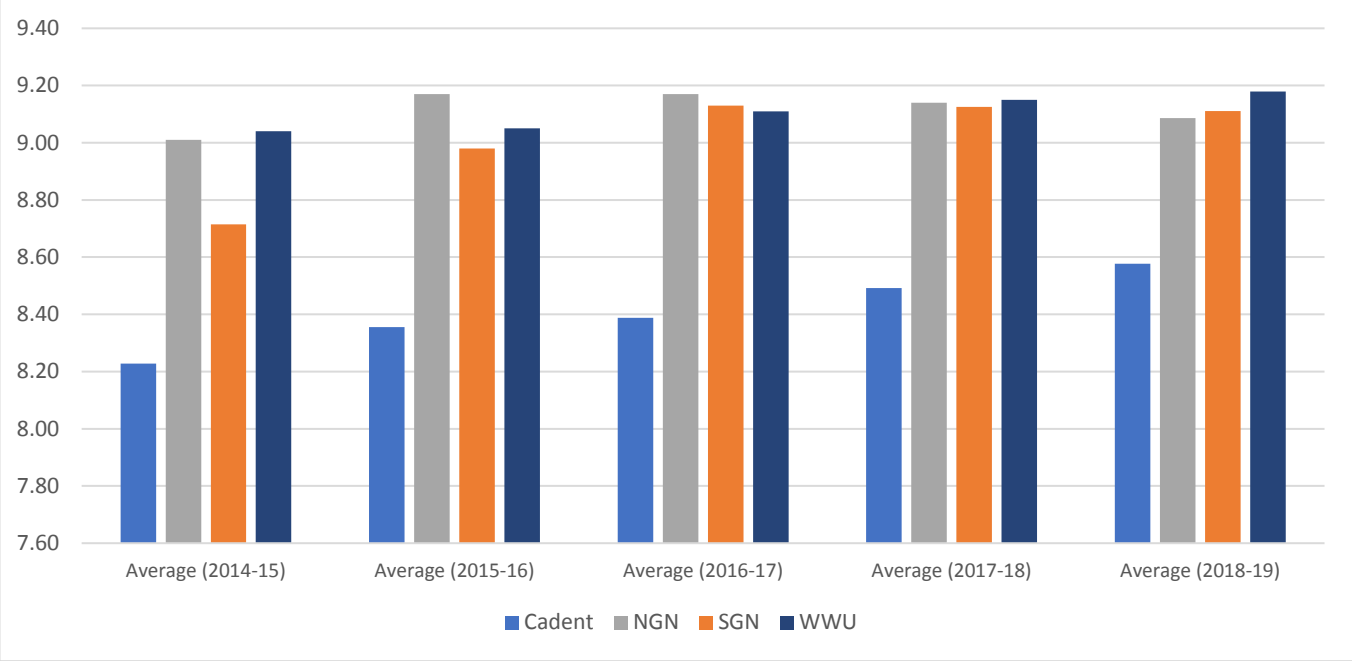
Figure 12. Customer Satisfaction Scores for Planned Works – November 2018

YTD (2018 - 2019) Planned	
Network	Score
Scotland	8.97
Northern Gas Networks	8.89
Southern	8.76
Wales & West	8.74
East of England	8.62
London	8.18
North West	8.16
West Midlands	7.69

There is a specific customer satisfaction output for 'planned work' which is focused on the repex programme. We ensure that we stay on target in the works we carry out through monthly reports and surveys monitoring any mains that develop into 'at risk' mains, where the risk score has exceeded the risk action threshold. Precautionary action is taken to ensure that at risk mains are prioritised to be decommissioned within a targeted timeframe.

As a network we are dedicated to our customers; accordingly, we are focussed upon collecting data from our customers following replacement works to help us improve our processes. In GD1 we have delivered a vast improvement in customer satisfaction scores for replacement, in excess of that seen in other GDNs. Furthermore, we have been able to maintain these scores. As demonstrated in table 4, when benchmarked against the other GDNs we have delivered the second highest score in 2018/19 based on an annual average.

Table 4: GDNs customer satisfaction scores over GD1



On an individual network basis for SGN in Southern and Scotland, we consistency deliver above the maximum reward goal for customer satisfaction, as seen below.

Figure 13. Scotland customer satisfaction scores

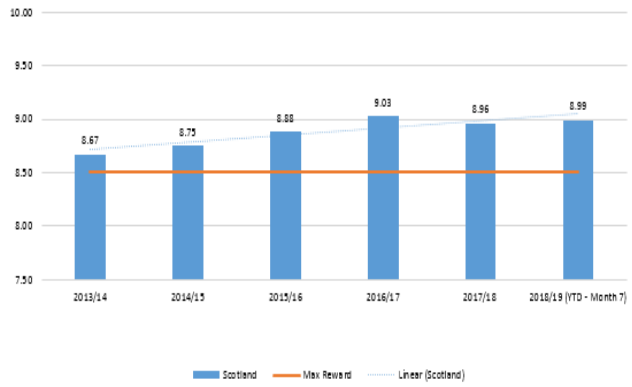
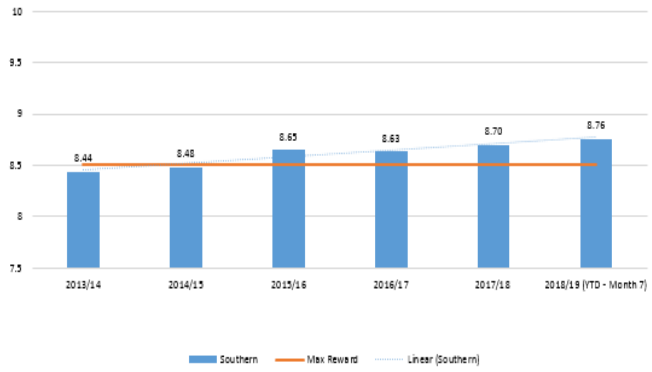


Figure 14. Southern customer satisfaction scores



Interruptions to customer supplies (risers in MOBs)

At the beginning of GD1 the number of supply interruptions exceeding 24 hours in duration which occurs in MOBs was already relatively low, particularly in Scotland where we have fewer MOBs than in our Southern network which includes London.

Whether an interruption occurs depends on the style of intervention which is required. Where the steel riser pipe supplying the building has failed we will aim to safely repair and maintain supplies. This allows any future intervention including full riser pipe replacement to be completed on a planned basis. Where a riser pipe must be disconnected on the grounds of safety, it is potentially challenging to immediately reconnect supplies, which may leave customers without a gas supply. Wherever possible, we have worked hard to avoid this second scenario.

In Scotland these low levels have been maintained during GD1. However, in our Southern network we have driven a further reduction of over 50%. This has been achieved by using new innovative pipe repair techniques to safely maintain supplies as well as the high operational priority we place on the decision process which would lead to a riser being disconnected where safety cannot be maintained. Table 5 below shows our performance in the first four years of GD1.

Table 5: Number of building risers disconnected for more than 24 hours

Number of Building Risers	13/14	14/15	15/16	16/17
Scotland	8	10	16	13
Southern	216	137	139	105

3.5 GD1 allowances and expenditure

Our current forecast is that repex expenditure will show a 12.9% variance to allowance while delivering all outputs. This variance is due to volumes, mix, project design and innovation and can be explained as follows:

Table 6: Tier 1 variances – eight-year forecast

Area	Sub Area	GDN View Driver	Sc (£m) 17/18 Prices	So (£m) 17/18 Prices
repex	T1 Abandonment Mix	Variation in mix over first four years, targeting higher risk pipes that are more prone to failures and GIBs (voluntary contribution)	6.9	45.0
repex	T1 Project Design	Holistic network analysis design, increased levels of mains laid by insertion, fewer larger projects	18.6	78.0
repex	T1 Volume variance	Increased length laid in Southern resulting from higher insertion levels	5.1	-40.3
repex	Contracting/Price	Change to contracting strategy to insource smaller contracting companies, price benefits resulting from project design	27.3	14.9
repex	Services Mix	Changes in the actual mix of service relays and transfers	0.8	12.8
repex	Service Volumes	Increased volume of services driven by mix of smaller diameter pipes in Southern	9.9	-27.9
repex	Service Price	Increased contractor price for service relays and transfers in Scotland, believed to be elements of contractual trade-offs between mains and services	-15.7	4.9
		Forecast GD1 T1 Variance	**52.8**	**87.3**

Negative numbers show actual spend is more than allowance; positive numbers show actual spend is less than allowance.

Table 7: Other repex variances – eight-year forecast

Area	Sub Area	GDN View Driver	Sc (£m) 17/18 Prices	So (£m) 17/18 Prices
repex	Tier 2	Positive volume and mix variances through better design offset by adverse price variance in both networks; price having greater Scotland impact	-1.0	31.9
repex	Tier 3	Conventional work in Scotland with mostly price variance; benefits in Southern driven by significant volume reduction (lay) as we deploy CISBOT	1.0	26.7
repex	2" steel	Reductions in lay compared to abandonment where we cut off back rails and renew services to the front; less unrecorded 2" steel feeding through	39.2	13.6
repex	Other Mains	Southern variance being driven by Totex trade-off (volume reduction) as we continue to maintain rather than replace – CBA driven	1.7	33.2
repex	repex Services	Positive volume and mix variances offset by adverse price variances	-1.5	-1.3
repex	Other Services	Scotland variance is mainly positive price variance; Southern is adverse volume and adverse price variances	5.9	-26.8
repex	Diversions	Mostly driven by adverse price variance	-5.8	-4.2
repex	Risers	Mix of repairs or remediation instead of full replacement; part renewals where possible; improved designs e.g. using PE; more completed on a planned rather than unplanned basis drives efficiencies	7.5	19.2
repex	Other repex	More efficient delivery of sub deduct programme; slow growth of smart metering programme	5.5	9.8
		Forecast GD1 Other Variances	**52.5**	**102.1**

Negative numbers show actual spend is more than allowance; positive numbers show actual spend is less than allowance.

Source: tables above showing variances were originally published in the 2017/18 SGN Strategic Commentary

3.6 GD1 lessons learned

Our assets, and the strategies we use for each of them, are all heavily interlinked. This section aims to highlight key factors which have driven cost variances in different asset classes in more depth, and the lessons we have learned through our approach to GD1.

Some of the key lessons we have learned in GD1 are:

- We have responded to the challenge of reducing planned interruptions by adapting our insertion technique to incorporate an increasing level of live insertion to reduce the level of interruptions to our customers and creating a greater opportunity to plan the interruptions to suit customers.
- Some work locations can be very challenging taking significant time to agree with local authorities. We can identify more problematic areas of work earlier and start the engagement processes earlier for things like permit schemes, local authority, highway authority, stakeholder and customer engagement.
- Having fixed target volumes of works hasn't allowed us in GD1 to flex workload between asset groups as emerging issues have come to light. We see a great benefit in using Network Asset Risk Measures (NARMs) in GD2 for a much more flexible approach.
- Having developed the use of self-amalgamating tape as an innovation project, we've been able to significantly reduce the number of risers needing to be cut off, by putting in the temporary repair to make safe, which has allowed us to reduce long-term interruption to customers and also to work more on a planned basis rather than reactive in our riser replacement programme.
- CISBOT is a technique we have brought in for our larger diameter pipes and have found significant benefit to customers in terms of achieving lower cost in comparison to conventional replacement techniques. It has greatly reduced disruption to road users as this robot goes through live gas pipes under the road, without having to dig up the road itself.
- Our approach to holistic design, looking at all the requirements on the network has meant we can consider mains replacement requirements, requirements to meet demand growth on the network through reinforcement and the governor replacement and refurbishment programme, all together has allowed us to optimise solutions that has sometimes allowed us to upsize replacement pipes to avoid reinforcement and on some occasions reconfigure the network to enable the removal of governors which would have otherwise been replaced.

We will meet in full our primary outputs and secondary deliverables in GD1 and there is no work to be deferred from GD1 into GD2, therefore there is no knock-on cost impact from GD1.

We manage our 'at risk' mains through monthly surveys and reports, which identify when the risk score exceeds the risk action threshold. We ensure these assets are prioritised to be decommissioned, usually within the following financial year subject to operational constraints.

4 Stakeholder insight

Stakeholder engagement has been a core focus for us while building our repex plans for GD2. We have engaged with stakeholders and customers through workshops, research and meetings, inviting their views on what they believe is most important in our programme. While doing so we have taken into consideration the differences we see between our Southern and Scotland networks, and therefore we have made a conscious effort to hold these stakeholder events individually for each network where necessary, as well as delivering consistency in what we are proposing to stakeholders for SGN as a whole in GD2. Details of all the engagement and research activities we have undertaken can be found in our Enhanced [Stakeholder] Engagement appendix (022) and our Stakeholder Engagement plan (appendix 024).

We recognise the importance of gaining stakeholder and customers' views on repex, as the amount of money we invest in this area of our business represents a significant proportion of our overall expenditure. Details of our approach to stakeholder engagement as well as valuable feedback from a variety of stakeholders within user groups, customer engagement groups and the GD2 Challenge group can be found in chapter 4 of our Business Plan and our Enhanced [Stakeholder] Engagement appendix (022). Some of the key stakeholders we have included in our engagement process consist of:

- The HSE
- Ofgem
- Local authorities
- UK and Scottish governments
- Domestic and business customers
- Consumer groups

SGN received very positive feedback for repex in our July Submission. Following feedback from the Customer Engagement (CEG), we held a stakeholder event around our engineering network investment plans for pipe risk management, asset integrity and network capacity management with a specialist panel of stakeholders. We received encouraging responses from the event. With the exception of one stakeholder per section there was no concerns or issues raised around the plans we have put together, or the process we have followed to develop those plans underpinned by our asset management strategy. One stakeholder stated *"GD2 feels more proactive than GD1, especially identifying steel as an increasing risk."* [2]

Our view of engagement when it comes to customers is that it is just as important for repex to include engagement with not only our existing customers, but also any new customers joining our network in the future. This is because the network is always expanding to support homes across Southern and Scotland and the Replacement programme must support this, as we need to cater to the needs of all potential end users. One of the key areas of discussion which we brought to some of our stakeholders was the option of accelerating the repex programme with our tier 1 workload. We explained how there is a value for money by doing so to both the company, stakeholders and customers. More detailed stakeholder feedback around our Accelerated option for tier 1 can be found later in this appendix, in section 6.1.

Our replacement work impacts on our stakeholders in a number of ways. We have categorised the key issues stakeholders have identified under our three commitments of making a positive impact, building a share future and delivering a safe and efficient service.

[2] Safe and Efficient round table event – London (Ref 089)

4.1 Positive impact

Disruption to other road users: when upgrading our network, it is often necessary for us to excavate the public highway, which can cause disruption for road users. We endeavour to use innovative techniques to minimise the number of excavations we need to make while undertaking replacement works. Once we have replaced a pipe, it is less likely to leak, avoiding future excavations (and the associated disruption) resulting from undertaking repairs to our network. Following engagement with stakeholders this has been factored into our Cost Benefit Analysis (CBA) when considering our required expenditure before investment decisions are made.

When planning works which will involve disruption to road users, the local authorities must give us permission to carry out the work and agree a duration. Where possible we seek to work collaboratively with other utilities in order to minimise the number of occasions on which the road space is restricted for users.

During GD1, a template for assessing projects proposals for investment through replacement of our pipes has included an explicit consideration of the impact on stakeholders. Once a project is approved for investment, our operational teams have adopted a tailored project delivery process for all mains replacement and major works projects, which cover our larger mains. This approach was endorsed by stakeholders at our Moving Forward Together workshops in 2017[3]. For each project, we map local stakeholders and assess the likely impact on the community. We then engage with those affected identifying bespoke communications using various channels and tailor our operational plans to meet local needs.

Throughout the stakeholder events there was a lot of emphasis placed on the importance of minimising impact and disruption and working closely with local authorities and building owners (particularly with regards risers) to minimise disruption and keep residents informed. At our Moving Forward Together workshops in January and February 2019, we asked stakeholders to consider the criteria they would apply when making investment decisions in our network. They were then asked, of those criteria, which were most and least important. Minimising disruption was rated as most important factor by stakeholders[4]. In addition, our willingness to pay research has revealed an appetite from both domestic and business customers for additional investment to reduce the duration of roadworks. Domestic customers would be willing to pay an additional £1.91 per year on their gas bills to reduce the duration of a six-week project on the public highway to four weeks[5].

4.2 Shared future

Environmental impact: in terms of its contribution towards climate change, methane is c.25 times more harmful than CO_2. Natural gas leaking from our network represents over 95% of our overall carbon footprint. Replacing metallic pipes with plastic is an extremely effective way of reducing this leakage, and consequently, our contribution towards climate change. A key recommendation of expert stakeholders at our sustainability round table events was that we should focus on reducing leakage from our network as it represents such a large proportion of our overall carbon footprint[6]. This was further endorsed by expert stakeholders at our shared future workshop in August 2019 [7]. Customers have identified minimising environmental impact as a priority and are willing to pay more for initiatives to reduce our carbon footprint when compared to other

[3] MFT Workshop March 2017 London, Portsmouth and Edinburgh (Ref 008, 009, 010)

[4] MFT Workshop January 2019 London and Glasgow (Ref 016, 017)

[5] Stage 3: Conjoint and WtP Summary report (Valuation Phase) (Ref 005)

[6] SGN Sustainability Roundtable – London and Glasgow (Ref 065,066)

[7] Share Net Zero Future round table event – Scotland (Ref 090)

potential improvements in our performance[8][9].

Meeting our future energy needs: it is still unclear how the UK will meet its need for heat in the future while also decarbonising energy supplies. Upgrading pipes to create a flexible network of plastic mains, accompanied by emerging smart technologies, will keep open the opportunity to potentially use the network to transport other decarbonised gases, such a hydrogen, in the future. Localised generators of green gases, such as biomethane producers, will also be able to continue to make use of the network[10] and mains gas could continue to play an important role as the primary energy source for supplying district heating schemes to new-build or converted households. The future proofing of the network and ensuring flexibility was a component of stakeholder and customer focus that came through strongly from our stakeholders and customers[11][12][13][14][15].

4.3 Safety and efficiency

Safety: the replacement programme is above all else an initiative to make our network safer, and we are required to replace iron pipes in order to comply with enforcement policy (IMRRP) issued by the HSE. We keep our customers safe by replacing the riskiest pipes first to minimise the potential of them leaking and consequently causing a gas explosion.

Reliability: new plastic pipes are far less likely to fracture and fail, resulting in a loss of gas supplies to end users. When compared to some types of metallic mains they are also less likely to suffer from water ingress when crossing saturated land, such as areas with a high-water table. The more we replace our pipes, the more reliable the pressures in our network.

Stakeholders and customers have consistently rated acting safely and keeping the gas flowing as among the highest priorities for us to focus on, as described in more detail in section 7. Our willingness to pay customer research revealed that 88% of customers would be willing to pay an extra 9p per annum to speed up the replacement of old pipes[16].

[8] Stage 3: Conjoint and WtP Summary report (Ref 005)

[9] Stage 3: Valuation Phase (Conjoint and WtP) Summary report (Ref 094)

[10] Biomethane and Gas Entry connections round table event (Ref 095)
[11] Stage 1: Explorative Qualitative Workshops and interviews (Exploratory Phase) (Ref 002)
[12] Stage 2: Max Diff Prioritisation Phase Report (Ref 003)
[13] Stage 3: Conjoint and WtP Summary report (Valuation Phase) (Ref 005)
[14] Specialist panel: Future of heat, Edinburgh 1 and 2 (Ref 023, 024)
[15] Share Net Zero Future round table event - Scotland (Ref 090)
[16] Stage 3: Conjoint and WtP Summary report (Valuation Phase) (Ref 005)

5 GD2 cross sector issues

5.1 Decarbonisation and whole system

Our vision is to develop a future network that will be flexible and adaptable, enabling multi-source gases to be safely and efficiently transported for customers. It will support a broad range of energy injection, storage and utilisation requirements including transport, heat and power generation. This in turn will contribute to the UK wide challenge of delivering energy to our customers in a clean, secure and affordable way having due regard to the balance that must be struck between these drivers. The continued replacement of metallic pipes with PE pipes is an important step on this pathway.

As we move into GD2 we aim to use similar principles to those we have previously worked to: maintaining a safe and reliable network. As there is not currently a single definitive solution to decarbonisation in the gas network, our primary focus remains to deliver energy safely and providing a reliable source of heat to our customers. Our investment plans are set to consider a range of investment opportunities which will provide additional customer benefits and the future role of the network. Examples of this are our steel mains programme and other emerging assets projects. The pipe risk management strategy looks out beyond the GD2 price control period, to 2032 when the tier 1 programme is due to complete. However, we fully expect that parts of the metallic mains population such as tier 2 and 3 iron mains and steel mains will require a continuing risk management programme after 2032.

As stated in the Environmental Action Plan appendix (Appendix 003), our GD2 strategy to accelerate the tier 1 iron mains replacement programme will realise a greater reduction in our carbon footprint more quickly, and we estimate we will be able to reduce leakage by 112,500 tonnes CO_2. Accelerating our repex programme also creates the additional potential benefit of increasing the network's preparedness for the potential future energy solution of hydrogen gas.

In our 'willingness to pay' research it was noted that 88% of our customers would be willing to pay 9p more on their gas bill to speed up the replacement of corroded pipes.

Various options for decarbonisation have been considered, some include; hydrogen gas, electrifying heat and biogas. Details on the future energy scenarios can be found in the Energy Systems Transition appendix (Appendix 006).

We are future proofing the network by replacing with PE pipe as it is proven to be suitable for the use of hydrogen. We are aiming to be the first gas network in the world to have a 100% up and running, end to end, hydrogen network which aligns with our H100 and Methilltoune projects, demonstrating full hydrogen solutions in terms of production, transportation and utilisation.

The Methilltoune project is developing innovation for producing hydrogen from harvesting electrical energy from green methods such as wind farms. Once hydrogen is produced our H100 project will demonstrate our existing network is suitable for the transportation of hydrogen and allow energy for heat be supplied commercially to existing properties that historically have used gas as their primary energy. The H100 project also considers the utilisation of this energy once it arrives to our customers with existing appliance conversion where appropriate and new development of hydrogen burning appliances.

We will also seek to enhance our data sharing with other organisations, particularly local authorities and other utilities, to support local authorities in their role of co-ordinating works, as set out in traffic management legislation. We are also actively engaging with other utilities to find opportunities to work together on projects – for example meeting with Thames Water. This was an area of interest to our stakeholders at a recent stakeholder event around safety and efficiency.

While we are in favour of working collaboratively with other utilities, co-ordinating our works to co-occur is not always the most efficient option to do so, for a variety of reasons:

1. The assets are not always in the same locations in the road
2. There may be a variation in the types of access required – for example due to our insertion methods, we do not require long trenches down the length of the road, which other utilities may still require
3. The timing of works is often difficult to co-ordinate as our priority is often different to other utilities

Despite these challenges, we still see merit in increasing the level of data sharing and forward understanding of our plans.

5.2 Innovation

Our financial performance has shown that we make a conscious effort to use our allocated budget wisely, and where possible, we aim to use innovation, communication and compliance to reduce expenditure. In terms of innovation we have delivered:

- Significant operation innovation portfolio established under GD1
- Innovation ranging from process changes through to future networks, industry standards and decarbonisation
- Recognised industry leader in the scope of innovation
- Recognised leader in the application of innovation into business practices
- Driving operational excellence through innovation and technology to deliver benefits to customers

Examples include:

- Seven operational ‘core and vac’ machines supporting repair and replacement activities for mains and services
- CISBOT robots have remediated over 39km large diameter iron pipes in the first six years of GD1
- Self-amalgamating tape has transformed our approach to risers repairs, significantly reducing outages
- Live insertion techniques reducing the number of customer interruptions
- Long handled tools for use in small core excavations reducing excavation hole sizes significantly

Innovation is embedded within our culture and is contained within our operational excellence strategic roadmap which contains an initiative to ensure this culture of innovation continues. As identified within the Gas Network Innovation Strategy, published on the ENA website, we identify projects against a number of key themes.

Table 8 summarises the work we have done so far across all the themes of the strategy since the start of GD1. The table below shows where we have focused our innovation efforts under the NIA scheme as well as the number of projects and benefit anticipated within GD1.

Table 8: Innovation themes

Strategy Theme	NIA	
	No. of projects	Benefit (£m)
Environment and low carbon	7	0.19
Future of gas	14	3.89
Mains Replacement	23	49.74
Reliability and maintenance	30	12.29
Repair	27	13.37
Safety and emergency	16	38.01
Grand Total	117	117.49

(Ref- Innovation appendix (008) -table 6)

By focussing our projects on these strategic themes, we have delivered benefits for the customer over the GD1 period. In comparison with a total projects value of slightly less than £8m, the Mains Replacement projects undertaken are expected to deliver a significant benefit of almost £50m over GD1 period.

We are continuing the development of a new innovative technique in GD2 which will be the first alternative for full pipe replacement since the 1970s, when PE was introduced for the first time. The project, called CIPP (cured in place pipe), uses an internal sleeve which is inserted and cured in place so that it lines the internal surface of the existing pipe. The redundant pipe now becomes a carrier, providing protection to the new internal pipe which contains the live gas supply. This method has now moved into its third phase with early development and testing of the CIPP liner technology having been conducted.

The HSE enforcement policy no longer places a requirement on gas distribution networks to replace all iron by 2032, and as such we will retain a population of large diameter pipes. We are continuing to develop CIPP for the replacement of large diameter iron to ensure that any new liners and fittings developed are hydrogen ready, in order that the remaining population of pipes can become hydrogen ready without the requirement or disruption of conventional replacement.

Taking innovation forward into GD2 we will optimise the projects that are inflight and close out their research and development (R&D) stages, moving them more towards facilitation and deployment. We will also continue to look at front-end implementation, using ‘off the shelf’ products. Such products and services will provide potential benefits to our efficiency ultimately meeting the needs of our customers. When looking at the facilitation and deployment we will also consider that innovation can be carried forward for use on the transition of our future energy system, for example a hydrogen network, as well as considering how we can reduce the disruption to our vulnerable customers. One such project is iCore which has developed tooling that will allow for keyhole work to be carried out, especially on our service replacements, resulting in a reduction in interruption times and the impact of reinstatement.

Throughout GD2 will use capital expenditure to purchase and implement high technical-readiness level (TRL) technology, in addition to R&D design work, to create more disruptive innovation.

Further detail of our strategy can be found in our Innovation appendices (008 & 013). In these appendices there

are detailed descriptions on how our lead innovation techniques have benefited our repex delivery so far. The following examples are just a few we have successfully implemented during GD1, which will be carried through into GD2:

CISBOT (Cast Iron Joint Sealing Robot)

ULC Robotics has developed a cast iron joint sealing robot known as Large CISBOT. This advanced robotic technology can repair cast iron pipe by internally injecting all the joints in a given area with an anaerobic sealant. This project carried out a detailed technical assessment and field trial of the joint sealing robot CISBOT, which has proven to repair or rehabilitate cast iron joints under live conditions.

Figure 15. CISBOT

The project delivered an innovative solution for the repair of leaking lead yarn joints within our large diameter cast iron mains population, and through GD1 became a critical part of our mains risk management strategy. The project evaluated the effectiveness of the repair technique and associated inspection method and was deemed to be very successful across the gas industry.

CISBOT has proven to be a valuable tool within innovation for GD1 and has strong stakeholder support. One of our major authorities, Transport for London (TFL), encourages the use of CISBOT within SGN as it significantly reduces disruption on the 'red route' roads of the London within our network footprint. Looking at a small selection of CISBOT projects carried out in the Southern network, there was an average cost saving of £450,000 per project by using the CISBOT robot in comparison to conventional replacement methods. In addition, CISBOT projects lasted an average of nine weeks, in comparison to an average of 27 weeks for conventional replacement. CISBOT's pioneering technology also reduces our carbon footprint, as it removes the requirement for multiple excavations in the road. Detail on how CISBOT will be used in GD2 can be found in section 6 of this appendix.

Serviflex service relay initiative

The re-laying of a domestic service can be carried out using a number of methods, the first part of this project focuses on extending the use of Serviflex for replacement of ¾" service pipes using the existing Serviflex pipe. A programme of development was put in place including modification of installation. The scope of this project was to investigate and develop the capabilities of the Serviflex product range to allow for service insertions with 20mm Serviflex, and live service insertion from the customer meter position. The objectives of the project were to:

Figure 16. Excavations

- Reduce the interruption time for customers requiring a service relay
- Reduce the cost of relaying a service to provide better value to the customer
- Reduce and where possible eliminate the amount of excavation and reinstatement

The successful development of the Serviflex system provides positive environmental benefits with a reduction in the number of excavations required, the time taken and the impact on the customer. Serviflex for 1 1/4" Steel Services is a corrugated dual wall liner that when used with specialist installation equipment can negotiate tight radius bends without compromise to the design life of the material.

Self-amalgamating tape

During GD1 we have implemented innovative techniques such as self-amalgamating tape which is used as an interim repair method allowing us to repair leaks and then, where necessary, plan works to replace the riser in future.

This was a simple innovation project that allows a repair on small joint leaks on our riser network. It provides a quick and simpler method than previous repair equipment that tended to be rather bulky. Time is reduced compared to conventual repair techniques and reduces the requirement for cutting off/disconnecting risers that leads to customer disruption and loss of supply.

Figure 17. Examples of self-amalgamating tape

We have also implemented Serviforge which is a method of anaerobically sealing the riser internally and can be used in the case of multiple joint failures as an alternative to replacing the riser immediately. The most recent innovative technique is the currently ongoing implementation of a technique called Microstop which utilises a bypass system to replace a small section of a riser due to condition rather than the entire riser. This also allows us to maintain the flow of gas while replacing the affected section of pipework. If we didn't have Microstop as a solution for replacing small sections of pipework, we would often have to replace the full riser. This would be a more expensive option which would take much longer in terms of planning as well as construction. It would also have a greater impact on customers as interruption to their supply will be necessary in the case of full replacement. The construction activity outside and inside the building would cause additional disruption to residents for a longer duration.

5.3 Resilience

Our repex programme is a key factor in the overall resilience of our network.

The completion of the HSE targets will substantially increase the resilience of the network by reducing the likelihood of fractures and pipe failures increasing safety and reliability. As fractures and failures are reduced then there is less reliance on the emergency and repair work teams as described in the Emergency Service appendix

and the Repair appendix (Appendices 013 and 014), and the network as a whole becomes more resilient as the proportion of polyethylene, which has an extremely low failure rate, increases.

As a specific example of improving resilience, the Kingsferry Bridge project (see project annex) which looks to increase the resilience of the gas supply to Isle of Sheppey where a single feed intermediate pressure main that is approaching the end of its useful life will be replaced thus protecting supplies to the 11,000 domestic, industrial and commercial customers on the island.

Pipe selection is data driven based upon those pipes that present the highest risk (20% of the length) and those pipes that have the highest probability of failure (80% of the length)

We undertake MRPS pipe surveys to ensure that our risk model is kept up to date with the conditions around the pipe location that influence the pipe risk model calculations. This ensure that pipe risk scores are updated to reflect and changes.

We have also used a data driven predictive analytics (PA) methodology to identify those pipes that have the highest probability of failure. A detailed explanation of this PA project and the benefits derived in terms of pipe selection is detailed in the EJPs for tier 1 iron mains replacement.

In order to quickly identify emerging local pipe failure concerns, we established a Condition Review Group at the start of GD1 comprising senior managers from both the Asset and Operations management teams. This group was established to consider feedback from front line operational managers around local pipe failures that were demonstrably impacting on safety, reliability, customer loss of supplies, highway users and any other affected stakeholders. This group is responsible for assessing the CBA of any interventions considered, applying our 4R approach, and will also determine and document where engineering judgement has been exercised.

The group also undertakes hot-spot analysis across a range of pipe asset groups to identify whether any atypical failure rates are being seen with local geographic areas. This is particularly the case for steel services where the HSE required the GDNs to confirm the arrangements they have in place for hot-spot monitoring and the process for taking action where an intervention (steel service renewals) is required. This has been detailed more fully in the Bulk Service Renewal EJPs.

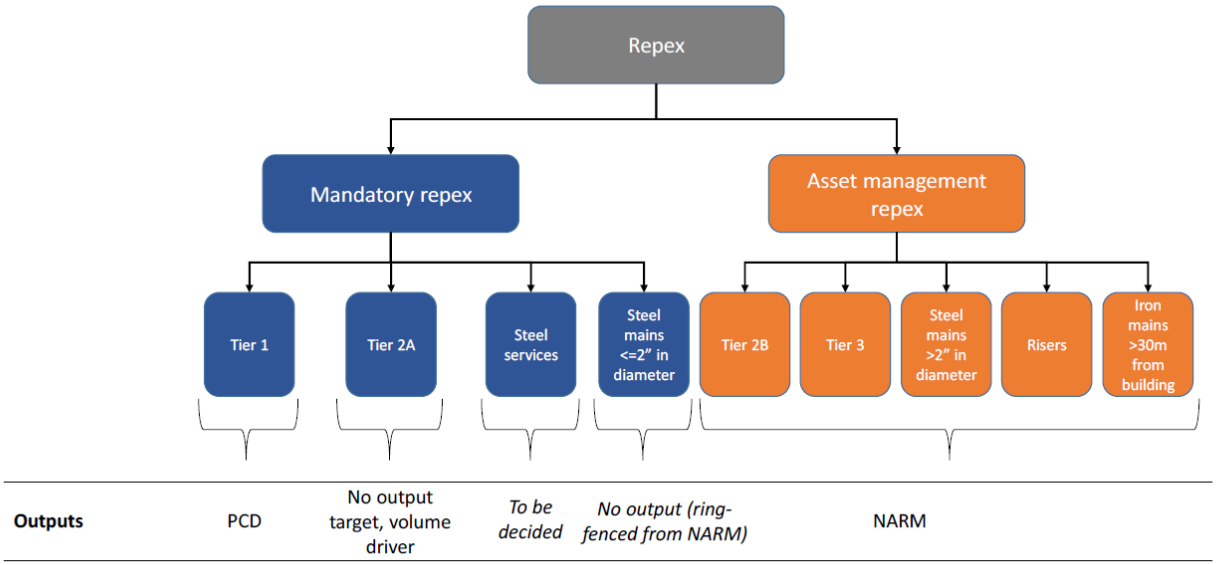
In GD2 this group will also assess interventions using the NARMs model to better understand and quantify the benefits of intervention versus continued maintenance and repair.

In taking this approach we aim to identify and target those pipes that present the greatest threat to the overall resilience of the pipe network while ensuring safety remains the overarching priority.

6 GD2 activity breakdown

In discussions between the GDNs, the HSE and Ofgem, we have jointly identified that our pipe risk management activities for GD2 fall into two categories: some activities are deemed to be mandatory, meeting safety and compliance requirements; while others form a part of our asset management strategy and are underpinned by monetised benefit analysis.

Figure 18. Pipe risk management activities/asset management strategy



As we transition from GD1 into GD2 we will continue to deliver on the requirements of the HSE enforcement policy for iron mains, decommissioning all tier 1 iron mains by 2032 and applying appropriate intervention to tier 2 and 3 iron mains. The HSE/Ofgem joint review in 2012 split the iron programme into three tiers, by diameter band. These tiers are then divided into separate categories: mandatory and asset management activities which are show in the diagram above.

- ## Planned workload – mandatory repex

Our strategy for each of these categories has been developed in line with HSE guidance that was given following a review of the iron mains replacement programme. In addition to managing the risks posed by iron mains within 30m of property, we have also set out our strategy for managing the risks presented by the remaining pipe population, including iron pipes in excess of 30m from a property, deteriorating steel, steel gas riser pipes supplying multi-occupancy premises and pipes of other non-standard materials such as asbestos which are planned for replacement when found.

Mandatory – tier 1

A length of tier 1 at-risk iron pipe to be decommissioned was agreed with the HSE at the start of GD1. 20% (by length) of those iron pipes with the highest risk score were selected for decommissioning, which are defined as mandatory tier 1 iron pipes. In reality the whole tier 1 iron main replacement programme is an HSE mandatory

requirement, however a risk action threshold sets apart the top 20% mandatory mains from the remaining tier 1 population.

The risk action threshold has been agreed with the HSE and any tier 1 pipes which exceed this threshold will be treated as if they are mandatory, to be decommissioned within the price control period.

As mandated by the HSE, we will identify the top 20% by length of those iron pipes presenting the highest risk and develop mains replacement projects around these pipes. The remaining 80% by length of iron pipes each year will be selected to optimise project delivery by maximising the size of each project and we will also deliver other benefits including reductions in gas leakage, mains repairs and impact on customers and stakeholders.

We have had discussions with the HSE and we have made it clear we fully support the continuation of the 20%/80% split as we believe it maintains consistency. We have looked at and considered carefully the option of moving away from the 20% approach, however based upon the experience of our operational colleagues, there are no foreseeable additional benefits through the economics of changing the approach.

Mandatory – tier 1 stubs

The HSE policy for tier 1 iron mains requires that they are all decommissioned by March 2032.

Prior to GD1 the HSE programme required us to replace all iron mains within 30m of a property by 2032, regardless of whether it was tier 1, 2 or 3. As a result, it had become common practice across all of the GDNs to leave short lengths of small diameter iron where it was connected to a larger diameter iron pipe that was not yet planned for replacement. This avoided the considerable additional costs of cutting into the large diameter iron main to remove the entire section of small diameter iron pipe. It was accepted practice that this short length would be decommissioned when the large diameter main was due for replacement which would have occurred before the 2032 deadline for all iron pipes. The cost difference was applied to the decommissioning of other iron pipes with GDNs agreeing with the HSE to deliver additional length.

However, a change in HSE policy that was introduced at the start of the GD1 period saw the introduction of the three-tier approach. This is described earlier in section 3.3 – Output delivery. As a result, the larger diameter pipes in tier 2 and tier 3 are no longer time-bound for completion by 2032. The knock-on effect of this policy change is that the natural driver that existed to remove the small diameter tier 1 iron pipes attached to tier 2/3 pipes has been removed meaning that without intervention some tier 1 iron beyond remain in service beyond 2032 which would currently result in non-compliance.

As a result, we have worked collaboratively with the other GDNs to explore potential solutions that can be presented to the HSE for consideration. We are currently in discussion with the HSE regarding the best approach to managing these stubs with other GDNs and in section 6.8 of this appendix have proposed an uncertainty mechanism to accompany this output.

The following figure 19 shows the split of 1,625 stubs that were shown in our asset records in 2018. We have also found there are more that have been created since the mains replacement programmes started back in the 1970s which are not on our records. figure 20 shows a typical arrangement.

Figure 19. All tier 1 stub

All Tier 1 Stub (Positive risk score only)

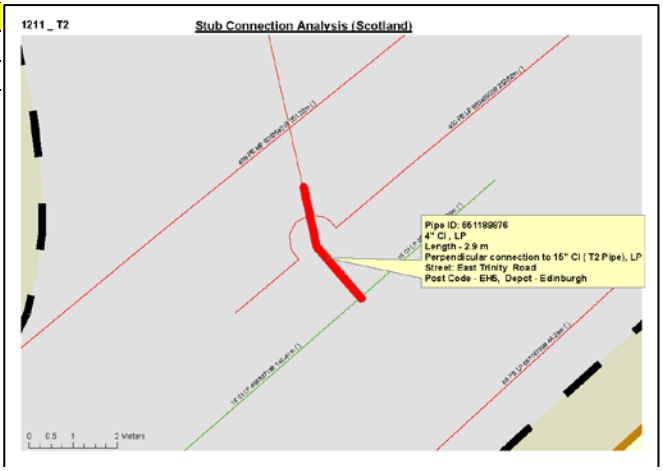
Connected to Tier 2 or Tier 3 Pipe

Southern		
Depot	Nos. of Stub	
London East	400	37%
London West	284	26%
Wessex	144	13%
Thames Valley	111	10%
Kent	79	7%
South Downs	53	5%
East Surrey	23	2%
Grand Total	1094	

Scotland		
Depot	Nos. of Stub	
Edinburgh	133	25%
Glasgow	141	27%
Coatbridge	130	24%
Dunfermline	54	10%
Paisley	36	7%
Dundee	37	7%
Grand Total	531	

Total (SGN):	1625

Figure 20. Stub connection analysis



Mandatory – tier 2 pipes above risk action threshold

In GD1 we proposed, and gained, HSE approval for a risk-based threshold for tier 2. Any pipes above that threshold are deemed to require a mandatory intervention. We have worked collaboratively with other GDNs to develop the MRPS system to a high standard to help enable us to identify when a pipes risk score exceeds that threshold. We will continue to use this stable process through MRPS to identify pipes that exceed the risk threshold requiring mandatory intervention during GD2.

As this workload is dynamic and requires a mandatory intervention within 12 months following identification, this makes the workload very unpredictable. We propose that the existing volume driver arrangements currently in place for GD1 remains an appropriate mechanism for GD2. Further supporting details are provided in section 6.3 of this appendix.

The remaining non-mandatory tier 2 iron pipes have been reviewed in line with the HSE enforcement policy requirements to ensure that we are properly considering opportunities for strategic design and efficient development of tier 1 projects. The HSE also recognises the need to consider the wider environmental benefits as well as our own commitment to deliver excellent customer service.

Mandatory – <=2" steel

Pipes that are discovered to be <=2" steel are classed as a mandatory pipe upon discovery to be decommissioned as soon as possible. Where practicable such pipes should be decommissioned immediately or planned as soon as reasonably practical. Our current forecast uses the run-rate in GD1 extrapolated forward.

Our current assets records for <=2" steel[17] show that we have 311km in Scotland and 267km in Southern. These assets however tend to be geographically specific according the standard practice at the time of lay. As such during GD1 we have moved from areas with a high volume of <2" steel to areas with a lower density of <2" steel as a result the associated work load decreased over that period from 59km per annum to 47km.

However, we do have analysis from our graphical maps system and asset record systems that show the potential for an increase on this run-rate in GD2 as the work in our replacement programme moves to areas such as Glasgow, Dundee and the south coast of England where our records show a higher density of <=2" steel. We have therefore proposed a volume driver for this investment and further supporting details are provided in section 6.3

[17] Part of the 'Diameter Band A' (<=3") steel population shown in tab 5.02 of the BPDT

of this appendix.

Mandatory – mains diversions

On an annual basis, we will complete several mains diversion projects on our <=7bar distribution network. These are required to enable the works of third parties, including highway authorities, other utility companies and developers. Most of these diversions can be recharged to the third party, but not all, and this will depend on the legal agreement in place.

- **Rechargeable diversions**. Mains diversions are usually third-party driven, resulting from highways work, other utilities activities and new building programmes. Most commonly it is possible to recharge for these works subject to New Roads and Street Works Act (NRSWA) and National Joint Utilities Group (NJUG) agreements for cost sharing which set out the methodology for sharing 'allowable costs' of diversionary works between the relevant parties. The highway authority may share with the GDN the 'allowable costs' of diverting or protecting the GDN's assets resulting from the highway authority's major works. This is known as the standard cost sharing principle which states that the highway authorities are entitled to 18% of the 'allowable costs' from the GDN. Typically, we see on average around 10.5km/year in Scotland and 12km/year in Southern of pipe decommissioned. The treatment of associated services is the same as for other mains decommissioned
- **Non-rechargeable diversions**. In a few cases we are not able to charge for the diversion and this is most commonly the case where a clause in the existing legal agreements requires us to remove the pipe and re-route at our own cost. Historically, workloads vary each year as they are predominantly driven by third parties. Typically, we see on average around 0.4km/year in Scotland and 0.6km/year in Southern of pipe decommissioned.

Mandatory – services relays/transfers (associated with mains replacement)

Typically, in the course of undertaking iron mains replacement, connected service pipes are either re-laid or transferred. The workload is driven by, and is proportional to, the total length of main decommissioned as part of this programme. Where pipes are remediated or deferred, we will consider whether the replacement of connected steel services should be completed at the same time.

We will continue to replace steel services on find when discovered while responding to reported gas escapes on the service, customer driven service and/or meter alteration works.

The scale of steel services is vast at present. However, we expect this to decrease as we replace them with PE. The historic run rate of finding steel services is very predictable as we have good records of the link between service renewals and mains decommissioning.

• Planned workload – asset management repex

Although we target certain asset groups as a priority under a mandatory programme we still have a requirement under the Pipeline Safety Regulations (PSR) to maintain other mains outside of the IMRRP and associated services. To manage the risk associated with these assets in GD2, mains and services will be subject to NARMs and CBA methodology to evaluate those presenting the highest risk.

The NARMs model gives us a formulated estimate of how our workloads will reduce the monetised risk value of particular asset groups in comparison to if we stopped the replacement programme. Detailed evidence can be found in the individual supporting EJPs around how this methodology is applied to our asset groups. For GD2 we are currently working on running our remaining populations for repex through this NARMs model to gain an understanding of what GD2 will look like in terms of monetised risk outputs. We have already run the model for a five-year period with a forecast of which pipes will be remaining. Evaluation of the probability of an asset failing

and the rate of deterioration provides a consistent basis for all asset classes.

As part of our strategy for GD2 we have investigated the risk of pipes and services outside of the IMRRP, which includes, but is not limited to: tier 2 pipes below the risk action threshold, tier 3 pipes, >30m iron pipes, >2" steel pipes, elective <=2" steel pipes and riser pipes.

Asset management – tier 2 pipes below risk action threshold

Within the tier 2 bracket there will be a variety of additional work excluding the tier 2 pipes above the risk action threshold. We will continue the process of tier 2 CRG generated projects, as explained in section 4.5.7 of the repex Technical Paper, as well as tier 2 short lengths associated with tier 1 and tier 2 lengths that pass the CBA.

When planning tier 1 projects for GD2, we have considered opportunities for strategic design and efficient development linked to replacement of non-mandatory tier 2b iron pipes, in line with guidance provided by the HSE. Where possible, the opportunity will be taken to design iron risk out of a network area entirely. This has the benefit of not having to return to an area on a piecemeal basis in the future to undertake repair works or further replacement works. We believe this is the right thing to do as it minimises disruption and is more efficient, in addition to avoiding stranding short lengths of iron in an otherwise polyethylene network.

Asset management – tier 3 pipes

Tier 3 pipes are designated as non-mandatory and, therefore, in our GD2 plan we have included a programme of pipe risk management, including refurbishment or decommissioning, of these pipes. We are required under the HSE enforcement policy to manage the risk of these pipes and where justified undertake some form of intervention which may include, but is not limited to, pipe replacement. We will continue to develop our innovation programme for iron pipes across all tiers, but we aim to specifically target large diameter where decommissioning and replacing a main is extremely high cost, highly disruptive and time consuming.

By using innovative tools such as CISBOT, when applicable, to remediate the larger diameters (tier 3 mains) as an alternative to replacement, we have been able to maintain a safe and reliable network while reducing costs and disruption to the community. Through this we have successfully reduced the risk of our tier 3 iron pipes, having remediated 39km of mains in the first six years of GD1.

As we have used this innovation on most of our high failure tier 3 mains through the course of GD1, going forward into GD2 there will be a much lower requirement to deploy CISBOT. For this reason, in GD2 we aim to only use CISBOT on a case by case basis which would be specific to those tier 3 pipes which have no pipe wall issues and also that specifically have lead yarn joints, as CISBOT cannot remediate other types of joint such as bolted joints. Additionally, we would only consider the use of CISBOT if it is found to be the most efficient option. Further detail on our approach to tier 3 mains with the use of CISBOT for GD2 can be found in our tier 3 EJPs in sections 3.0 / 3.1 and 4.2.

Asset management – iron pipes >30m from property

The focus of the HSE, through the IMRRP, is on iron pipes within 30m of a property as this is deemed to be the distance with the highest risk of an incident. However, we also have a smaller population of iron pipes in excess of 30m of a property that present operational risks and loss of supply risks should these pipes fail and require repair works. In considering these additional risks, we have identified a need for some pipe replacement.

Iron pipes in excess of 30m from a property are becoming a concern from an operational safety perspective, with increased risks to our operatives when working on these systems due to the catastrophic corrosion failure of the pipe while undertaking an excavation to gain access for a repair. Where a pipe is the only feed into a small town or village, failure of that pipe also presents a risk to the continuity of supply to that area. All such projects are assessed internally through our Condition Review Group (CRG).

Asset management > 2” steel pipes

All GDNs have engaged in a collaborative piece of work to assess the steel population and the rate of deterioration, the likelihood of failure and the impact on our customers. This information will be used to identify the steel pipes which should be prioritised for replacement. An additional proactive programme of work has been included in our GD2 plan, in comparison to the failure driven run-rate that has been completed in GD1.

The HSE are supportive of a more proactive approach to fulfil our absolute legal duty under the pipeline safety regulations and stated would endorse a proactive programme. Even though Ofgem view this as asset management activity, underpinned by CBA, it was clear that CBA is not the only criteria for asset intervention/replacement.

More information around this investment area can be found in our supporting >2” steel EJPs (SGN repex - 007/008) and CBA.

Analysis of current failure rates suggests that a proportion of our steel mains population are already in a deteriorating condition and may reach the end of their useful life during the GD2 period, thus ceasing to be considered fit for purpose. Extensive deterioration, usually comprising severe corrosion of the pipe wall, results in an ongoing requirement for mains repair. Those mains operating within the low-pressure range (<=75mbar) are also prone to water ingress, particularly where the water table has risen above the pipe. In the case of single feed systems this has sometimes resulted in a loss of supply to our customers. With pipes operating at medium pressure (>75mbar to 2bar) there is an additional operational safety risk associated with physically working on these pipes in the course of excavating down on to the pipe to affect a repair.

We are proposing to implement a proactive steel programme in GD2 with a modest workload to tackle those steel pipes with the highest failure rates and creating the most significant disruption to our customers. From working collaboratively with the other GDNs and external consultants AESL, we now have significant supporting data to develop a risk management approach for these assets where we better understand the risks they pose, the rate at which they deteriorate, the likelihood of failure, and the impact on our customers. We will use this information to prioritise these steel pipes for replacement. The steel corrosion review provides a detailed risk analysis of steel pipes across the UK for all of the GDNs; and in SGN it will form a part of the information we will use to prioritise pipes for replacement. Our approach to replacing our steel population will be to split the pipes into smaller cohorts with each group in descending order having a lower level of risk based on their failure history. Our strategy will be to target the highest risk pipes first in the top cohort. These cohorts are currently being developed in order to identify the highest priority work.

Asset management – other mains policy and condition

There is a population of mains that falls outside of the IMRRP and are also not part of a key material or asset group which we proactively replace, as the risk is generically low. These mains consist of non-standard material pipes, which refers to those pipes recorded and made from materials other than polyethylene, steel, cast iron, spun iron, ductile iron or copper. Example non-standard materials are asbestos and PVC. The current policy approved by the HSE is to decommission pipes of a non-standard material when found and this gives rise to a small annual workload. However, for the larger population of PVC pipes in our Southern network, this should be by 31 March 2032 in line with the iron mains programme.

The scale of these pipes is small, and we do not currently expect volumes to increase. We currently know the location of all live non-standard material pipes and seldom find new ones, all of which are tracked monthly.

Asset management – gas risers to MOBs

We have a large population of pipes, typically steel, constructed inside of high rise and low rise multi occupancy premises. The consequences of a significant pipe failure, potentially resulting in a gas explosion, are much higher than for a single domestic property. As well as the high population of residents in multi occupancy buildings there will often be a vulnerable population residing in these buildings, including sheltered accommodation for the elderly. This makes it important to ensure security of supply as well as avoid incident. We therefore propose to continue with our existing risk management programme to reduce the risks presented by these pipes over the GD2 and beyond.

We consider it important to continue with the same levels of investment in GD2 as we have seen in GD1, to continue to replace our ageing assets at the rate they are deteriorating and to minimise asset failure, replacing reactively rather than proactively. An EJP (SGN repex – 009 / 010) and CBA are available to support this investment.

Figure 21. Risers requiring replacement

Prior to GD1 we were doing some proactive replacement of risers as part of the mains replacement work, but during GD1 this has also been expanded to include standalone riser replacement work. This change in process was supported by the implementation of the RRM and the risk-based approach and prioritisation given to individual assets. Along with the introduction of the RRM, we introduced a comprehensive inspection and risk assessment regime and it is the output from these that informs our prioritised replacement programme, working on a top down basis. We consider this best practice to deal with riser risk. This has been discussed with the HSE who are supportive of our risk-based approach and prioritisation system.

The majority of risers, particularly high rise, were installed at a similar time between the late 1960s and 1970s and as such are at or near the end of their asset life. The risk-based approach allows us to prioritise those risers most at risk and with highest consequences of failure, considering the condition and any other issues with the pipework, in addition to the building size, population and consequences in the event of an incident.

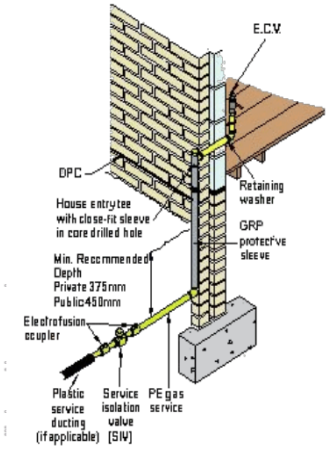
The approach taken in GD1 has led to a much more proactive way of working, therefore minimising leakage as well as customer supply interruptions, which is why it is vital that we continue to deliver similar levels of work in the future. This will not only ensure we are operating a safe and reliable network but will also keep customers and stakeholders satisfied and engaged with the work that we do.

In our GD2 plan we have also included additional survey costs for MOBs greater than six floors to ensure the continuing accessibility of riser isolation valves located outside of the building that can be operated, if required, in an emergency situation whether directly gas related or otherwise. These surveys will confirm that each valve can still be identified on site and remains accessible which may not be the case if work by other parties has inadvertently compromised access. We will specifically target external valves on new riser installations where the riser risk survey is undertaken every 10 years and this interim valve inspection will be undertaken at a five-year interval.

Asset management – bulk service renewals (not associated with mains replacement)

We have utilised a service insight tool to identify problem areas for services within the network. The tool is designed to highlight areas where the services have demonstrated a consistent history of leakage. As part of our strategy for GD2 we are looking at possibilities of creating projects for these areas of service renewals. In addition, several service pipe integrity issues have been identified and submitted to our CRG which will need to be addressed during the GD2 period. These services fall outside of the normal planned mains replacement programme and are better described as bulk service renewals. These services for instance may be already connected to a PE main with steel tails contained within their construction or steel services connected to tier 3 mains. In table 9 and table 10 below we have forecast the annual amount of services we are proposing to complete in GD2 for both Scotland and Southern.

63mm PE service above ground entry



Asset management – asset integrity (named projects)

We have identified a small number of atypical intermediate pressure pipe risk management requirements which have been individually named. These projects are all supported with individual CBAs and EJPs, and we anticipate completion of the main works contract in the early part of GD2. In each case, the failure of these pipes mains would result in a major loss of supply incident. Details of these named projects can be found in the project annex.

- ## Proposed Workload Summary

All the assets in repex, in both the mandatory and asset management categories, have a workload associated with them for GD2. In the tables below we have listed the workloads we are proposing, on an annual basis for both Southern and Scotland, showing the different options we have considered where applicable. As shown below, our accelerated tier 1 iron option is to increase our rate of replacement for tier 1 by 15km per year in Scotland and 25km per year in Southern. We are also proposing the introduction of a proactive programme of >2" steel replacement increasing over and above the current failure drive run-rate by 10km per year in Scotland and 22km per year in southern. Details of the supporting evidence for these additional options can be found in sections 6.2 and 6.4 of this appendix, and also in our tier 1 iron and >2" steel and iron >30m EJPs.

Table 9: Scotland - summary of GD2 workloads per year

Category	Activity Category	Unit	Option 1– Linear/Run Rate	Option 2 – Accelerated/Proactive
Tier 1	Mandatory	km	214.1	229.1
Tier 1 Stubs	Mandatory	#	69	–
Tier 2A	Mandatory	km	0.5	–
<=2" steel	Mandatory	km	25.8	–
Mains Diversions	Mandatory	km	10.5	–
Services Relays/Transfers (associated with mains replacement)	Mandatory	#	19,214	20,251
Tier 2B	Asset Management	km	4.7	–
Tier 3	Asset Management	km	1.7	–
Iron pipes >30m	Asset Management	km	1.6	–
>2" steel	Asset Management	km	2.8	12.8
Other Mains Policy and Condition (excluding T1 Stubs)	Asset Management	km	4.3	–
Risers (Number of Buildings)	Asset Management	#	126	–
Bulk Service 'only' Renewals	Asset Management	#	300	–
Other Services (not associated with mains replacement)	Asset Management	#	1,257	–
Asset Integrity (named Projects)	Asset Management	#	1	–

Table 10: Southern - summary of GD2 workloads per year

Category	Activity Category	Unit	Option 1 – Linear/Run Rate	Option 2 – Accelerated/Proactive
Tier 1	Mandatory	km	618.8	643.8
Tier 1 Stubs	Mandatory	#	142	–
Tier 2A	Mandatory	km	2.7	–
<=2" steel	Mandatory	km	23.8	–
Mains Diversions	Mandatory	km	12.7	–
Services Relays/Transfers (associated with mains replacement)	Mandatory	#	57,723	59,868
Tier 2B	Asset Management	km	7.5	–
Tier 3	Asset Management	km	4.4	–
Iron pipes >30m	Asset Management	km	0.6	–
>2" steel	Asset Management	km	7.7	29.7
Other Mains Policy and Condition	Asset Management	km	8.1	–
Risers (Number of Buildings)	Asset Management	#	689	–
Bulk Services 'only' Renewals	Asset Management	#	750	v
Other services (not associated with mains replacement)	Asset Management	#	7,948	–
Asset Integrity (named Projects)	Asset Management	#	2	–

6.1 Approach to GD2

Our plan is based upon similar levels of investment to those forecast during the current price control period (GD1) but reflecting some adjustments to the workload mix to reflect the updated risk profile as we move into the 2020s.

We will continue to manage the risk of small diameter iron pipes in line with the HSE IMRRP which mandates that all such pipes must be decommissioned by the end of March 2032. There was a series of incidents resulting in fatalities around the time the IMRRP was put in place, one of the most well referenced was at Larkhall, Scotland where a family of four was killed. Therefore, this work forms a substantial element of our overall pipe risk management investment programme.

In addition to the safety risk reduction delivered by this plan and the increased levels of system reliability, we will also deliver another significant reduction in gas leakage from the old iron and steel pipes in our network together with an associated reduction in carbon intensity. Reductions in our emergency and repair workloads which will result from renewing these pipes have also been factored into our overall Business Plan. These environmental and opex expenditure impacts are additional benefits of our pipe risk management interventions.

Our tier 1 iron pipes are deteriorating at a higher rate in comparison to our other pipes. Consequently tier 1 iron pipes are continuously being repaired upon failure for both >30m and <30m of a property and account for circa 80% of the repair costs in GD2. The Gas Safety (Management) Regulations 1996 Reg 7(5) require us to prevent gas escaping from a failed pipe within 12 hours of being informed. We usually achieve this by fitting a repair clamp around the pipe or sealing a leaking joint.

Our iron mains risk reduction programme, as well as delivering the mandated 20% highest risk tier 1 pipes, both impacts and is responsive to the number of repairs on a pipe. The more repairs a pipe experiences the higher the risk score will be. This will influence the priority and timing of pipe replacement. As a result of our continued replacement programme we will see repair workloads reduce as our replacement activities increase the amount of PE pipes, removing the risk of fractures and joint leakage.

By installing replacement PE pipes, we will continue to develop a network that can offer greater flexibility and adaptability in the future to transport different gases and blends of gases, consistent with many of the future energy pathways currently being considered. We therefore see these necessary investments to manage existing safety requirements as a low regrets approach.

We will continue our journey to address the challenges of the UK carbon reduction targets and seek to ensure that the gas network has a part to play in a future integrated energy solution that offers multi-source, multi-use, flexible operation. We aim to remain flexible in supporting the transition to a low-carbon future. We will build on the strong safety performance we have delivered in previous price control periods where we have met and often exceeded all prior targets set for us by our principal regulators, Ofgem and the HSE.

The forecast expenditure profile seen in table 11, distinguishes between mandatory repex (HSE driven IMRRP mains and services) and asset management repex (non-HSE driven mains and services, steel riser pipes supplying multiple occupancy building and a small number of named asset integrity projects). Key trends include:

Asset management repex including:

- Non-HSE driven mains and service workloads will continue at broadly similar levels to the final years of GD1, albeit with a different workload mix to reflect current risk management requirements. Tier 2 and tier 3 iron workloads will decrease and >2” steel volumes will be increased as part out our proactive/precautionary programme.
- Refurbishment and replacement of steel risers will continue at broadly similar levels to the final years of GD1.
- A small number of specific asset integrity projects are included which are atypical and are shown separately

with supporting justification.

The following tables summarise our actual and forecast expenditure in GD1 and our proposed investment in GD2

Table 11: GD2 forecast expenditure profile (£m)

SGN (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Mandatory HSE Mains & Services	190.3	187.1	179.9	193.5	193.5	184.0	189.7	187.1	205.5	206.7	205.1	204.4	205.2
Non HSE Mains & Services	30.4	31.9	36.2	38.2	52.1	65.0	66.4	66.2	40.2	39.5	38.4	37.5	37.0
Steel Risers	11.6	12.8	13.3	14.8	13.2	17.0	17.7	16.7	17.5	17.5	17.4	17.3	17.4
Other repex									7.1	0.7	0.7	0.7	0.7
Total	**232.3**	**231.8**	**229.4**	**246.5**	**258.8**	**266.0**	**273.8**	**270.0**	**270.2**	**264.5**	**261.6**	**260.0**	**260.3**
Scotland (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Mandatory HSE Mains & Services	48.6	47.3	52.7	50.2	47.8	48.0	46.0	45.9	53.5	53.8	53.3	53.2	53.6
Non HSE Mains & Services	6.8	7.3	7.9	9.8	12.6	19.6	17.6	17.2	9.2	9.0	8.8	8.7	8.6
Steel Risers	1.4	1.7	1.7	1.5	1.5	3.1	2.6	2.7	2.8	2.8	2.7	2.7	2.8
Other repex									0.7	0.7	0.7	0.7	0.7
Total	**56.8**	**56.2**	**62.4**	**61.4**	**61.9**	**70.8**	**66.3**	**65.8**	**66.2**	**66.3**	**65.6**	**65.3**	**65.7**
Southern (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Mandatory HSE Mains & Services	141.7	139.9	127.2	143.4	145.8	135.9	143.7	141.2	152.0	152.9	151.8	151.3	151.6
Non HSE Mains & Services	23.6	24.6	28.3	28.4	39.5	45.4	48.8	49.0	31.0	30.5	29.6	28.9	28.4
Steel Risers	10.2	11.1	11.5	13.3	11.7	13.9	15.1	14.0	14.7	14.7	14.6	14.6	14.6
Other repex									6.4	0.0	0.0	0.0	0.0
Total	**175.5**	**175.5**	**167.0**	**185.1**	**196.9**	**195.3**	**207.6**	**204.2**	**204.0**	**198.2**	**196.1**	**194.7**	**194.6**

The following tables summarise our proposed length of new mains laid in GD2.

Table 12: Mains laid workloads – SGN (km)

SGN		2022	2023	2024	2025	2026	Total
T1 Length Laid	km	847.1	847.1	847.1	847.1	847.1	4,235.7
T2 Length Laid	km	15.5	15.5	15.5	15.5	15.5	77.4
T3 Length Laid	km	6.1	6.1	6.1	6.1	6.1	30.8
Steel Length Laid	km	72.1	72.1	72.1	72.1	72.1	360.5
Other Length Laid	km	5.4	5.4	5.4	5.4	5.4	27.1
Total	**km**	**946.3**	**946.3**	**946.3**	**946.3**	**946.3**	**4,731.5**

Note: Figures exclude Diversions/T1 Stubs.

Table 13: Mains laid workloads – Scotland (km)

Scotland		2022	2023	2024	2025	2026	Total
T1 Length Laid	km	216.0	216.0	216.0	216.0	216.0	1,080.0
T2 Length Laid	km	5.2	5.2	5.2	5.2	5.2	26.0
T3 Length Laid	km	1.7	1.7	1.7	1.7	1.7	8.6
Steel Length Laid	km	30.5	30.5	30.5	30.5	30.5	152.4
Other Length Laid	km	2.4	2.4	2.4	2.4	2.4	12.1
Total	**km**	**255.8**	**255.8**	**255.8**	**255.8**	**255.8**	**1,279.2**

Note: Figures exclude Diversions/T1 Stubs.

Table 14: Mains laid workloads – Southern (km)

Southern		2022	2023	2024	2025	2026	Total
T1 Length Laid	km	631.1	631.1	631.1	631.1	631.1	3,155.7
T2 Length Laid	km	10.3	10.3	10.3	10.3	10.3	51.4
T3 Length Laid	km	4.4	4.4	4.4	4.4	4.4	22.2
Steel Length Laid	km	41.6	41.6	41.6	41.6	41.6	208.1
Other Length Laid	km	3.0	3.0	3.0	3.0	3.0	15.0
Total	**km**	**690.5**	**690.5**	**690.5**	**690.5**	**690.5**	**3,452.3**

Note: Figures exclude Diversions/T1 Stubs.

The following tables summarise our proposed length of old mains decommissioned in GD2.

Table 15: Mains decommissioning workloads – SGN (km)

SGN		2022	2023	2024	2025	2026	Total
T1 Length Decommissioned	km	872.9	872.9	872.9	872.9	872.9	4,364.3
T2 Length Decommissioned	km	15.5	15.5	15.5	15.5	15.5	77.6
T3 Length Decommissioned	km	6.1	6.1	6.1	6.1	6.1	30.8
Steel Length decommissioned	km	92.1	92.1	92.1	92.1	92.1	468.9
Other Length Decommissioned	km	14.6	14.6	14.6	14.6	14.6	73.2
Total	**km**	**1,001.2**	**1,001.2**	**1,001.2**	**1,001.2**	**1,001.2**	**5,006.2**

Note: Figures exclude Diversions/T1 Stubs.

Table 16: Mains decommissioning workloads – Scotland (km)

Scotland		2022	2023	2024	2025	2026	Total
T1 Length Decommissioned	km	229.1	229.1	229.1	229.1	229.1	1,145.3
T2 Length Decommissioned	km	5.2	5.2	5.2	5.2	5.2	26.2
T3 Length Decommissioned	km	1.7	1.7	1.7	1.7	1.7	8.6
Steel Length Decommissioned	km	38.6	38.6	38.6	38.6	38.6	201.5
Other Length Decommissioned	km	5.9	5.9	5.9	5.9	5.9	29.7
Total	**km**	**280.5**	**280.5**	**280.5**	**280.5**	**280.5**	**1,402.6**

Note: Figures exclude Diversions/T1 Stubs.

Table 17: Mains decommissioning workloads – Southern (km)

Southern		2022	2023	2024	2025	2026	Total
T1 Length Decommissioned	km	643.8	643.8	643.8	643.8	643.8	3,219.0
T2 Length Decommissioned	km	10.3	10.3	10.3	10.3	10.3	51.4
T3 Length Decommissioned	km	4.4	4.4	4.4	4.4	4.4	22.2
Steel Length decommissioned	km	53.5	53.5	53.5	53.5	53.5	267.4
Other Length Decommissioned	km	8.7	8.7	8.7	8.7	8.7	43.5
Total	**km**	**720.7**	**720.7**	**720.7**	**720.7**	**720.7**	**3,603.6**

Note: Figures exclude Diversions/T1 Stubs.

The following tables summarise our proposed number of service interventions in GD2.

Table 18: Service intervention workloads – SGN

SGN		2022	2023	2024	2025	2026	Total
Tier 1 Services	#	74,879	74,879	74,879	74,879	74,879	374,397
Tier 2 Services	#	1,351	1,351	1,351	1,351	1,351	6,758
Tier 3 Services	#	17	17	17	17	17	87
Steel Services	#	3,500	3,500	3,500	3,500	3,500	17,502
Other Services (awr)	#	244	244	244	244	244	1,220
Other Services (nawr)	#	11,082	10,647	10,234	9,843	9,470	51,275
Total	**#**	91,073	90,639	90,227	89,835	89,463	451,239

Note: awr/nawr – associated with mains replacement/not associated with mains replacement.

Note: Figures exclude Diversions

Table 19: Service intervention workloads – Scotland

Scotland		2022	2023	2024	2025	2026	Total
Tier 1 Services	#	17,664	17,664	17,664	17,664	17,664	88,322
Tier 2 Services	#	305	305	305	305	305	1,526
Tier 3 Services	#	12	12	12	12	12	62
Steel Services	#	2,156	2,156	2,156	2,156	2,156	10,782
Other Services (awr)	#	66	66	66	66	66	330
Other Services (nawr)	#	1,681	1,616	1,554	1,496	1,440	7,786
Total	**#**	**21,884**	**21,819**	**21,758**	**21,699**	**21,644**	**108,807**

Note: awr/nawr – associated with mains replacement/not associated with mains replacement.

Note: Figures exclude Diversions

Table 20: Service intervention workloads – Southern

Southern		2022	2023	2024	2025	2026	Total
Tier 1 Services	#	57,215	57,215	57,215	57,215	57,215	286,075
Tier 2 Services	#	1,046	1,046	1,046	1,046	1,046	5,232
Tier 3 Services	#	5	5	5	5	5	25
Steel Services	#	1,344	1,344	1,344	1,344	1,344	6,720
Other Services (awr)	#	178	178	178	178	178	890
Other Services (nawr)	#	9,401	9,031	8,680	8,347	8,030	43,489
Total	**#**	**69,189**	**68,820**	**68,469**	**68,136**	**67,819**	**342,432**

Note: awr/nawr – associated with mains replacement/not associated with mains replacement.

Note: Figures exclude Diversions

In the Scotland table 19 we have included an additional 103 service interventions per year of 'other services not associated with mains replacement' where we have proposed to reconfigure intermediate pressure services installed up to the building line. This is not an issue in Southern.

6.1(a) Impact of government policy

Our GD2 Business Plan proposal allows for an agile and flexible approach to adapt to potential new government policies. Government has been considering several policy areas over the past few years and new policy relating to those areas may or may not emerge during GD2:

- Decarbonising heat and transport – including the use of hydrogen and heat networks
- Enquiry into high-rise buildings following Grenfell
- Any changes in wider regulations or legislation through gas sector regulatory agencies and bodies

In terms of responding to potential government policies on hydrogen or heat networks, our accelerated mandatory replacement programme option (which is reflected in the workloads submitted in our plan) would prepare our network to accommodate hydrogen in the PE pipes earlier than would otherwise be the case. Therefore, we would not expect any impact on the workload estimates for tier 1 iron if the accelerated option is approved.

Furthermore, our innovation focus for GD2 is to inform the feasibility of such low-carbon gas networks and gather evidence to enable such government policy. We have several innovation projects planned to continue into GD2 which would make us ready to adapt to any hydrogen or heat network related policies as follows:

- Project Methilltoune and H100 – a world-first connecting households in Scotland to a green hydrogen production facility from renewable energy
- Project Cavendish – connecting Medway households and London industrial sites supporting the decarbonisation of transport and heat to a hydrogen network

See section 5 of this appendix and our Energy Futures appendix (001) for more detail.

As our 4R investment strategy ensures that we retain optionality and facilitate a variety of future energy scenarios, we consider that any changes in decarbonisation policy are more likely to impact GD3 forecasts, with our work in GD2 preparing us to respond quickly.

Through the inclusion of re-openers and other uncertainty mechanisms such as volume drivers and ‘use-it or lose-it’ allowances, we will be able to respond to any other potential government or regulatory policy changes, for example around risers, steel pipes, iron stubs, etc, while ensuring customers are protected from the otherwise inclusion of a risk premium. Section 6.9 in this appendix sets out in detail our proposed uncertainty mechanisms.

6.1(b) Scenarios and sensitivities

As part of our proposals for GD2 we have compiled several scenarios into 13 individual CBAs for the different workload categories. In each of the CBAs we have carefully considered the 4R strategy to decide the best approach to the GD2 programme, while also aligning this with the Ofgem options scope. An example of our options considered would be the view of repairs on mains within a workload category in comparison to full replacement in order to justify costs.

We have also included sensitivity analysis in our preferred options in our CBAs due to the uncertainties we may face in GD2. How we manage some of these uncertainties is explored in section 6.8 of this appendix. As detailed in our EJPs there are several variables which use a +/- 5% swing to build an illustration of what these scenarios might look like. These variables include:

- Capital cost
- Repair on failure
- Methane content (fixed time series data)
- Loss of supply/compensation
- Fatal/non-fatal injury

- Leakage (CH4)

Five per cent is used as a variance as we do not expect, nor have we seen, any large-scale unexpected movements in price or workload associated with maintaining and/or replacing these assets.

There are sensitivities that are common across all CBAs, which include investment +/-, benefits +/-, and pathways for gas, however there are also some bespoke sensitivities which we have built into our CBAs such as customer risk, health and safety risk and leakage.

6.2 GD2 outputs and price control deliverables

Outputs

As stated in section 1 of this appendix, we intend to align our outputs for each workload category in GD2 to the 4R strategy which has been successfully used through GD1 – this being the decision between Repair, Refurbish, Replace, or Rebuild. The repex programme often plays a part in all of these mechanisms; by carrying out mains replacement works the number of repairs on the network is reduced, and our innovation through GD1 and continuing into GD2 allows us to consider refurbishment of mains as a means of risk management and maintaining a safe and reliable network. In terms of 'Rebuild', our strategic design process for replacement allows us to plan our works in a way that minimises the need in some areas for complete rebuilds of elements such as governors, often our design allows us to safely remove governors completely from the network.

In relation to the workloads and expenditure shown in section 6.1, we plan to deliver through various outputs as listed in table 21 below.

Table 21: Proposed outputs table

Asset group	Mains	Steel Services	Aligned with Decision Doc
Tier 1 Iron Mains	Length Decommissioned (km) PCD Length Exceeding the PCD into NARMs	NARMs	Yes, see below
T1 Diameter Mix	Tolerance on Diameter bands 1-4 +/- Length Decommissioned (km)		
T1 Iron Mains Stubs	PCD (# of Stubs) Use-it-or-Lose-it allowance requested	N/A	See below
Tier 2A Iron Mains	No Output – Volume Driver (forecast in BPDT)	Volume Driver	Yes
<=2" steel Mains	No Output – Volume Driver (forecast in BPDT)	NARMs	See below
Mains Diversions	No output – Customer Driven	N/A	Yes
Tier 2B Iron Mains	NARMs	NARMs	Yes
Tier 3 Iron Mains	NARMs	NARMs	Yes
>2" steel Mains	NARMs	NARMs	Yes
Iron Mains >30m	NARMs	NARMs	Yes
Risers to MOB Properties	NARMs	NARMs	Yes
Other			
PE Service Transfers	NARMs		Yes
Bulk Service Renewals	NARMs		Yes
Named Projects	NARMs		See below
IP Reconfiguration	PCD		See below

Tier 1 output – A length (km) Price Control Deliverable (PCD) with any work completed in excess of the agreed PCD contributing to the overall NARMs output. NARMs outputs up to the limit of the PCD cannot be traded out to other investment areas.

T1 stubs – Very short length tier 1 pipes <3m in length measured by a PCD of the number of stubs where an intervention to manage risk has been undertaken.

<=2" steel mains – Given some uncertainty over future volumes, we have set out an uncertainty mechanism using a volume driver. No output is therefore proposed for these mains.

Named projects – Two atypical intermediate pressure steel replacement projects feeding into the NARMs output.

IP reconfiguration – Risk management of intermediate pressure service pipes terminating immediately at the

property line proposed as a PCD of the number of services.

Table 22 below sets out the length, number and financial value of these outputs:

Table 22: Outputs table (figures)

Asset Group	Output	Units	Southern	Scotland	SGN
T1 Mains (inc Diversions)	PCD	km	3,225	1,150	4,375
T1 Stubs	PCD	#	711	345	1,056
IP Service Reconfigurations	PCD	#	0	515	515
<=2" steel Mains	No output – volume driver				
T2A Mains and Services	No output – volume driver				
All Other Mains	NARMS	£m	6.43	1.75	8.18
Services	NARMS	£m	6.13	1.07	7.20
Risers	NARMS	£m	1.01	0.17	1.18
Total repex (NARMs)	**NARMS**	**£m**	**13.57**	**2.99**	**16.56**

Table 23 below shows proposed volume drivers.

Table 23: Volume drivers

Asset Group	Output	Unit	Average Lay Unit cost – Sc	Average Lay Unit Cost – So	Comment
<=2" steel Mains Only	No output – volume driver	£/m	£85.1	£195.6	Mains Only
T2A Mains and Services	No output – volume driver	£/m	£641.7	£691.0	Mains and Services

Note: All figures above exclude overheads.

Our cost driver is predominantly an average lay unit cost driven largely based on costs coming from contractors, provision of services and provision of materials that are all competitively tendered for, detail of which can be found in section 6.9 of this appendix and in Appendix 010 – Procurement and native competition.

Price Control Deliverables

Tier 1

As part of our plan for GD2 we have considered alternative strategies to enhance this programme of works. Our preferred option, after detailed consideration and discussions with stakeholders, is to accelerate the programme. Workload and cost for this are shown in our GD2 investment pack, however to summarise, our forecast workload for Tier 1 (inclusive of our accelerated option) in GD2 is 1,145km in Scotland at a cost of £178m, and 3,219km in Southern at a cost of £504m, over the five-year period (excluding Diversions). The justification for this can be found in the below section, and a more detailed view is included in our tier 1 EJPs (SGN repex – 001/002).

For any tier 1 which is delivered over the set expenditure, this will be covered through the NARMs output.

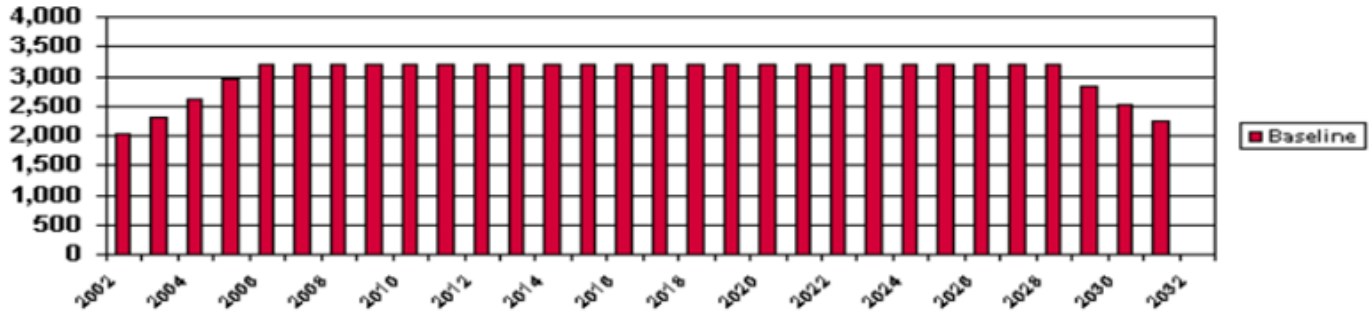
- **Accelerated option for tier 1**

Although our proposals originally provided a linear approach and is the least cost/low regret approach, there are risks around purely maintaining safe and reliable network workloads towards the end of GD2. Accelerating the programme will bring significant benefits and risk reduction in terms of resourcing as well as pipe risk management and emission reduction, but at additional cost.

Additional investment into repex will also benefit customer bills if we are replacing pipes at a quicker rate. We estimate that every £5m of repex spent not spent in GD2 will change the customer bill on average by 11.7p per year.

If we were to follow this scenario, we would look to accelerate our tier 1 workload to allow a tail off at the end of the programme, which is something that the HSE envisaged for all the gas distribution networks at the start of the iron mains programme, as shown in figure 22 below.

Figure 22. HSE UK 30/30 baseline tier 1 profile to 2032, all GDNs, 91,000km



We have engaged with our stakeholders on two options for completing the remainder of our T1 iron programme. These options are:

- Flat line to the end: Our current base case for delivering the HSE Mandatory Iron Programme by 2032 for all small diameter iron mains (T1<=8")
- Accelerate and tail off at the end: As an alternative, we could do more work in each year of GD2, which would allow us to reduce the annual workload in the last few years. This would remove some of the risk of failing to deliver the programme.

These options are fully explained in the tier 1 iron EJPs.

We received overwhelming support from stakeholders on the accelerated option for tier 1, which is the basis upon which we have selected this as our preferred option.

At a stakeholder workshop titled 'Shared Future', during discussions around the future of energy one of the key insights shared was:

- Some felt that there was a potential to be more ambitious given the climate change emergency declaration.

This feedback shows a stakeholder perspective on delivering a more ambitious plan and how they see it as a benefit in terms of the environmental factors.

At the same event, there was discussion around reducing the business carbon footprint and how accelerating the mains replacement programme contributes to this, with stakeholders showing interest in SGN having an appetite

for accelerating it in order to reduce shrinkage. With all discussions arising through stakeholders, it was important to us that we develop our plans to include what our stakeholders expect from us in order to have a safe and efficient network.

As part of this accelerated option we are committing to decommission a total of 40km additional pipes per annum – 15km of tier 1 iron pipes in Scotland and 25km in Southern. We would anticipate that this will be included in the tier 1 PCD and have the same average lay unit cost. As a result of this additional tier 1 workload we expect to reduce leakage as shown in table 24 below.

Table 24: Leakage reduction per annum in tCO2e

	2021/22	2022/23	2023/24	2024/25	2025/26
Current approach to repex	29,156	29,365	29,558	29,803	30,191
Initiative	**Reduction per annum in tCO2e**				
Acceleration of repex	0.704	0.690	0.706	0.760	0.740

A detailed view of the options considered, and the result of the CBAs can be found in the tier 1 EJP and the associated CBA (SGN repex – 001/002).

Tier 1 diameter mix

As per decisions made in the sector specific methodology (May 2019) we are currently working towards setting a tolerance banding around tier 1 diameter bands decommissioned.

We sometimes opt to increase the size of a lay pipe in order to mitigate alternative mains reinforcement-only schemes through the marginal increasing of replacements pipes at a short-term marginal cost, rather than subsequent, and greater, longer-term reinforcement costs. Therefore, we want to be able to flex the diameters to increase the size of some lay pipes, to provide the opportunity for a more holistic approach to design which allows us to defray reinforcement costs. The alternative would be to contain our replacement schemes within the agreed tolerance bands and then lay discreet reinforcement projects at a significantly higher cost to customers. This could also create increased disruption due to multiple visits to the same pipe location.

Conversely, should we find better ways to design the network and increase levels of insertion, we should be able to design smaller pipes and install smaller pipes at a lower cost to ourselves and customer and share the benefit of that through our Totex incentive. We should not be penalised for doing that as the alternative is to lay larger pipes that aren't required, just to fit within the diameter band tolerances set and avoid penalties.

Asset integrity (named project) – IP reconfigurations

One of our named projects, which is in Scotland, is IP/LP Service Reconfiguration. Due to historical practices we have some properties that are connected to the intermediate pressure network rather than the low-pressure network. While there is no indication that this is unsafe, an intermediate pressure connection alters the risk profile which is something that we are currently evaluating in terms of the benefits of reduced risk and the cost of making a change. This is described in more detail in the project annex. We are proposing a small cost to replace and downgrade these services to a low-pressure network to ensure minimal risk is achieved.

We are proposing this named project as a price control deliverable of number of services reconfigured. We estimate a total workload of 515 services over GD2 at a cost of £3.7m. We have two other named projects which are detailed in section 6.4 of this appendix, both of which are in our Southern network and will be covered as

NARMs outputs.

6.3 Bespoke outputs

Below we have set out our bespoke outputs that we have worked through to gather the appropriate stakeholder evidence (both HSE, and customer) and the appropriate technical evidence to support our decision for these output choices. The repex programme does not carry much scope for bespoke outputs due to our mandated duty to manage risk through the IMRRP, however there are uncertainties in some of our work categories which are best funded through mechanisms such as a volume driver or a use it or lose it allowance.

Tier 1 iron stubs

As described in section 5 of this appendix under Mandatory – tier 1 stubs, there is no longer a mandatory requirement to replace tier 2 and tier 3 mains and therefore, there is no natural driver to decommission these stubs. The GDNs have jointly commissioned a piece of work with an external engineering consultancy to complete a risk assessment for these stubs. The report is now complete and has been submitted to the HSE for consideration and we are currently awaiting its initial response.

If the HSE is in agreement with our proposals, then this would mean those tier 1 stubs would no longer be classed as pipes but as fittings and no longer part of the IMRRP. As part of that we will transfer the risk score from the stub onto the parent main. If the HSE agrees to that proposal, we currently estimate that around 65% of those stubs would come under this category of becoming a fitting on the parent main. If the HSE agrees this then we would not have to carry out work on those pipes. This agreement is in process; however, we will not have final approval in time for our December Business Plan submission.

We require a use-it-or-lose-it allowance in GD2 for 1,056 (65%) of these stubs which we are discussing with the HSE. It is uncertain that agreement will be reached before we start GD2. We are forecasting expenditure of £8.7m over GD2 to decommission/replace these stubs at an average unit cost of £8,239 per stub.

If the HSE approves our proposals the use-it-or-lose-it allowance, we are seeking can be reviewed and potentially reduced significantly. On the remaining 569 Stubs (35%) where the length of the stub cannot be treated as a fitting, the decision from the HSE will be that they will remain a tier 1 pipe to be decommissioned as part of the enforcement programme. However, there are options available around utilising different innovative techniques for risk management over and above cutting the pipe out of the parent main. This is an area we are exploring, with a view for a separate submission to the HSE with work being completed during the GD3 period, in advance of the March 2032 deadline.

Tier 2a iron pipes

During GD1 we have replaced all the mains that have been identified exceeding the HSE threshold based upon the Mains Risk Prioritisation System (MRPS). We continually monitor the remaining tier 2 pipes that previously had a low risk threshold, some of these may go over the risk action threshold within GD2. We call this dynamic growth, and over time as circumstances change this can impact the pipe's score. Such events are pipe leakage, new houses being built near our pipes and changes in the ground between properties where our pipes are situated (such as ground being paved over, leading to increased risk of a gas leakage entering a property). These events cause fluctuating pipe scores and therefore are monitored, although volumes are difficult to forecast.

We are proposing the best investment option for these pipes given the uncertainly they hold is to continue with the same investment we used through GD1 and continue with a volume driver. We are currently proposing a workload of 2.5km of dynamic growth for Scotland tier 2A pipes and 13.5km for Southern tier 2a pipes in GD2, based on the workload we have seen in over the course of GD1. The cost associated with these workloads is £10.7m in Southern and £2.2m in Scotland with an average lay unit cost of £794.7/m in Southern and £868.4/m in Scotland. Details on how this mechanism would be applied to manage the uncertainty can be found in section 6.8

of this appendix.

<=2" steel

For <=2" steel we are requesting a volume driver. This is due to the levels of uncertainty around workload volumes and the need to de-risk the network. Details on how this mechanism would be applied to manage the uncertainty can be found in section 6.8 of this appendix.

We have based our current GD2 forecast on the run-rate of the last three years of GD1 historical decommissioning lengths and extrapolated this forward. This is lowest point of the GD1 period, and as the work in our replacement programme moves to areas such as Glasgow, Dundee and the south coast of England where our records show a higher density of <=2" steel we expect that this will increase, however, this is not certain.

In GD1 we forecast to deliver 414km of <=2" steel at a cost of £42.8 m with an average lay unit cost of £140.3/m over the last three years. In GD2 we have extrapolated forward to forecast 248km at a total cost of £36m, with an average lay unit cost of £117/m in Scotland and £231/m in Southern (average over five-year period). This breaks down to 129km for Scotland and 119km in Southern over GD2.

As a result, rather than forecast expenditure according to predicted volumes and expose the customer to the risk of those forecasts not being realised, our forecast is based on the lower historical trend and we are proposing a volume driver as the most appropriate balance of risk between ourselves and the consumer for any excess volumes. Without such a volume driver, we would look to revert to a GD2 forecast that is based on our GIS and asset record systems resulting in an increase to our current forecast.

Mains diversions

Diversions has no proposed output as it is primarily a customer driven activity, typically local authorities, highway authorities and other utilities who are promoting new work that requires us to divert our gas mains.

In the case of rechargeable diversions, a contribution for any required works can be sought from the customer but in some cases discounted for up-front payment or deferment of renewal (replacement before the existing pipe has reached end of life).

Non-rechargeable diversions are typically a very small workload and occur when, for example, a clause in a legal agreement is triggered requiring us to relocate a pipe at our cost.

Our forecast investment for Diversions in GD2 is broadly similar to that seen through GD1, as we are proposing a workload over GD2 of 53km in Scotland and 63km in Southern for both rechargeable and non-rechargeable diversions combined.

6.4 Investment in existing assets – CBA/NARMs

Monitoring asset health is key in maintaining a safe and reliable network. We primarily monitor asset health through the IMRRP with the use of the Mains Risk Prioritisation System (MRPS) determining our top 20% of risk in our population, however we have also implemented other mechanisms such as the Riser Risk Model (RRM), the insight tool for services as well as the NARMs and CBA tools. We identify our asset health spend profiles in section 9.2 of our repex EJPs. All of these are used for different aspects to assess the health of our assets and determine their resilience.

The tables below show the monetised risk with and without intervention and the risk delta for the entire pipe risk management programme. However, when setting targets for GD2 the monetised risk values solely represent those activities not covered by a PCD or an uncertainty mechanism (volume driver). Please refer to tables 21, 22 and 23 in section 6.2 where we set out our proposals for GD2 targets covering both PCDs and monetised risk.

Table 25: NARMs outputs Scotland

£m monetised risk			2021	2026		
	Secondary Asset Category	Funding Category	Without intervention	Without intervention	With intervention	Change in risk (Delta)
repex	T2b iron mains	A1	7.2	8.9	8.4	0.5
	T3 iron mains	A1	6.4	7.8	7.3	0.4
	Steel mains >2"	A1	11.2	13.0	12.1	0.8
	Services	A1	25.7	28.7	27.6	1.1
	Risers	A1	1.7	2.1	1.9	0.2
	T1 iron mains	A3	13.1	15.6	7.8	7.8
	PE Mains	A2	3.7	4.0	4.2	-0.2
	Steel mains <=2"	A2	2.0	2.4	1.2	1.1
	Other mains	A2	0.0	0.0	0.0	0.0
	T2a iron mains	A2	1.0	1.3	1.2	0.1
	Total		**72.0**	**83.7**	**71.8**	**11.9**

Table 26: NARM's outputs Southern

£m monetised risk			2021	2026		
	Secondary Asset Category	Funding Category	Without intervention	Without intervention	With intervention	Change in risk (Delta)
repex	T2b iron mains	A1	27.6	34.6	33.4	1.3
	T3 iron mains	A1	70.8	88.7	85.2	3.5
	Steel mains >2"	A1	9.5	11.3	9.6	1.7
	Services	A1	38.8	43.8	37.6	6.1
	Risers	A1	3.5	4.1	3.1	1.0
	T1 iron mains	A3	46.9	58.7	31.8	27.0
	PE Mains	A2	9.2	9.8	10.4	-0.6
	Steel mains <=2"	A2	23.6	28.1	26.7	1.4
	Other mains	A2	0.5	0.5	0.5	0.1
	T2a iron mains	A2	14.7	18.4	17.8	0.7
	Total		**245.1**	**298.2**	**256.0**	**42.1**

In section 5 of our EJPs there are diagrams to demonstrate some of the methodology behind the NARMs model, how the monetised risk is calculated and how factors of the NARMs model convert into a cost.

Our chosen investment option provides benefit to our customers as well as managing the risk of our pipes. For a more detailed view of monetised risk on an asset level, please refer to the individual EJPs and their corresponding CBAs.

The outputs we have seen for monetised risk are fed into our CBAs for each asset group to enable us to accurately analyse our investment options, a summary of our CBA results is detailed in section 6.5 of this appendix.

Asset groups included within NARMs as investment outputs are listed below:

Tier 2 below the risk action threshold and tier 3

Our tier 2 below the risk action threshold and tier 3 workloads will be part of our NARMs output. We are proposing modest workloads and expenditure for these assets in GD2, although as shown in the workload and expenditure tables for Southern and Scotland in section 6.1, these are significantly less than what we delivered in GD1. This still leaves us in a positive position in terms of customer and stakeholder expectations as well as delivering the programme through GD2. We are proposing a workload over the five-year period of 23.5km in Scotland and 37.7km in Southern for tier 2b and 8.6km in Scotland and 22.2km in Southern for tier 3 (excluding diversions), with the below average lay unit costs.

Table 27: Average lay unit cost – £/m decommissioned

Network	Tier 2b	Tier 3
Southern	£533.7	£678.5
Scotland	£350.58	£759.31

>2" steel

AESL's steel corrosion report has shown us that we are seeing increasing failures year on year because the volume of >2" steel replacement we are currently undertaking on a reactive basis is insufficient to stay in line with the rate of deterioration. Having consulted with the HSE in terms of the risk profile of these pipes, we are proposing to take a more proactive approach in GD2 and the workload forecast we have submitted as part of our plan is aimed at reducing steel failure rates per km of pipe installed. Our Steel EJPs for Southern and Scotland (SGN repex – 007/008) give detailed support for this programme of works, however a summary of our reasoning for the programme and workloads we are proposing is also shown below.

The consequence of failure for steel are mostly:

- Methane emissions to atmosphere
- Customers going off gas – supply failure due to poor pressure or water ingress
- Water ingress causes a risk of gas getting into a property and causing an incident

We have consistently seen issues over the GD1 period of customers being off gas due to water ingress and sometimes persistently. Due to the rigid and strict CBA procedure used in GD1 it is not uncommon for us to continue to repair those pipes and arrange to pump water out of them, but this has occasionally led to persistent problems for customers.

The results of the AESL report combined with the support we have received from the HSE gives strong justification for our modest yet proactive approach to steel in GD2.

There is also an element to be considered around the safety of our operatives, especially when failures occur on the higher pressure systems. In high demand conditions it is very difficult to put in place a pressure reduction on the higher pressure systems and although we have precautions and additional safety measures in place around these particularly higher risk situations, it creates a more challenging safety environment in which to work.

Our proposal for GD2 therefore comprises two discrete elements based upon:

1. Our current run rate of steel pipe failures resulting in decommissioning and replacement.
2. An additional proactive programme of replacement aimed at reducing methane emissions, improving safety and reducing customer unplanned interruptions to supply.

The following table 28 sets out our proposals:

Table 28: Our proposals

Activity	Scotland		Southern	
	GD2 Cost £m	GD2 Abandon Length km	GD2 Cost £m	GD2 Abandon Length km
1. Run Rate	1.01	14.04	6.78	38.56
2. Proactive	3.61	50.00	19.35	110.00
Total	4.62	64.04	26.14	148.56

The average lay unit cost in Scotland is £103/m and in Southern is £245/m.

The costs, workloads and average lay unit costs above do not include the two named projects for Security and Security , which we describe separately further down in this section and in the project annexes.

We have proposed that this will be measured as part of the overall NARMs output.

As a result of this proactive workload we expect to deliver significant benefits in the reduction of leakage, as shown in table 29 below.

Table 29: Leakage reduction per annum in tCO2e

	2021/22	2022/23	2023/24	2024/25	2025/26
Current approach to repex	29,156	29,365	29,558	29,803	30,191
Initiative	**Reduction per annum in tCO2e**				
Proactive steel programme	1.504	1.515	1.544	1.542	1.559

Iron mains >30m

As shown in our proposed outputs table in section 6.2, our output for iron mains >30m is in line with what was stated in Ofgem's Sector Specific Methodology Decision. These assets will be covered under the NARMs outputs. There is also detail in our steel EJPs (SGN repex – 007 / 008) which describe our delivery and rationale for iron mains >30m. We are proposing a workload of 8km in Scotland and 3.3km in Southern, over the five-year period (excluding diversions) at a cost of £124.50m in Scotland and £424.00m in Southern. We forecast an average lay unit cost in Southern of £410.70/m, and in Scotland £158.03/m.

Risers

Riser costs comprise two parts:

The first element is highly certain as it relates to installing the pipes, which is not significantly different to repex replacement. In simple terms, the only difference is that the installation is elevated, rather than in the ground.

The second element is more difficult, as it can be challenging to complete all the additional work involved in the working arrangements to create a safe environment in which our engineers can work, for example requiring scaffolding and working with cladding. There is also additional work required to provide a more attractive outlook externally on the building, as well as safety arrangements for the public. Lastly, there can be additional challenges such as working inside kitchens to relocate the ECV from the inside walls to the outside.

The cost of the additional work described above can often exceed the cost of the actual installation, and as such we are using NARMs as an output for risers.

Our riser EJPs (SGN repex – 009/010) detail a technical background of risers as well as justification behind our chosen approach for GD2.

Services associated with mains replacement

We have developed our GD2 forecast workload based upon historical data from our regulatory returns in GD1. These enable us to forecast the number of service interventions per km of main decommissioned and also the split between service relays and service transfers. This is further split down in the Business Plan Data Template (BPDT) by services to domestic and non-domestic premises. A summary of our forecast workloads and costs are shown in the table 30 below.

Table 30: Services interventions associated with mains replacement – GD2 summary

	Workload (#) Per Year	Cost (£m) Per Year	Average Unit Cost (£/service)
Scotland	20,204	14.7	728
Southern	59,789	44.1	738

PE service transfers

As shown in our proposed outputs table in section 6.2 our output for PE service transfers is in line with what was stated in Ofgem sector specific methodology agreement. These assets will be covered under the NARMs outputs.

Bulk service renewals

As shown in our proposed outputs table in section 6.2 our output for bulk service 'only' renewals is in line with what was stated in Ofgem's Sector Specific Methodology Decision.

As part of the response to Ofgem with regard to our bulk service renewal programme this will be set out as stated in option 3 in section 4.29 of our Sector Specific Methodology Decision – not set a PCD output: "Replacement of non-PE services would be included as part of the NARM which would be the main mechanism for ensuring the efficient delivery of non-PE service replacements over GD2". Our original plans were to set this area of work as a volume driver, however looking at it from a risk perspective, it is best covered by the NARMs process.

The reason our unit cost for other services is different to that of relays and transfers is because it is an unplanned job, this incurs additional costs whereas with planned works there is forward notice and planning and costs are included in a budgeted cost.

Details of our rationale for this programme of works can be found in our bulk services EJPs for Southern and Scotland (SGN repex – 014/015) along with accompanying CBAs. A summary of our proposed workloads and costs in shown in the table 31 below.

Table 31: Bulk service renewals – GD2 summary

	Workload (#) Per Year	Cost (£m) Per Year	Average Unit Cost (£/service)
Scotland	300	0.48	1,597
Southern	750	0.96	1,278

Asset integrity – named projects

We are proposing three named projects for investment in GD2, 2 of which are in Southern and are proposed as NARMs outputs. The third named project is in Scotland and can be found above in section 6.2 as a price control deliverable. All three projects are detailed in our project annex. Our named projects are to be submitted as a NARMs output.

The two specific named GD2 repex projects in Southern are where the costs associated with this work are atypical. These projects are not like any work we've undertaken in GD1 and are individual bespoke construction projects that are very different to normal repex work with exceptionally high unit costs.

The cost associated with these named projects are shown in table 32 below.

Table 32: Named projects average cost (£m/year)

Named Project	Cost £m / year
Security	0.98
Security	0.29
IP Service Pipe Reconfigurations	0.74

Each of these named projects has an individual EJP and CBA to support our proposals (SGN repex – 011/012/013).

6.5 Engineering Justification Papers

We have gathered strong supporting evidence for each investment area to explore the different investment options and find the most effective approach for any project or programme that is greater than £500k. Along with these papers there is corresponding CBAs which support the methodology behind each investment decision.

Altogether the CBAs account for the investment of £1,154m out of a total repex expenditure of £1,317m across the five years of GD2. Along with these papers there is corresponding CBAs which support the methodology behind each investment decision. These are set out in the following table 33 and are submitting along with the CBA payback period we have for each investment area. With our current investment decisions, all our asset groups are passing a CBA at a minimum of a 45-year payback period.

Table 33: CBA/EJP summary table

Network	Asset	Value £m	CBA Payback	Engineering Justification Paper
Southern	Tier 1 Iron	244	28 years	SGN repex - 001 Tier 1So - EJP Dec19
Scotland	Tier 1 Iron	3	39 years	SGN repex - 002 Tier 1Sc - EJP Dec19
Southern	Tier 2b Iron	76	23 years	SGN repex - 003 Tier 2bSo - EJP Dec19
Scotland	Tier 2b Iron	17	25 years	SGN repex - 004 Tier 2bSc - EJP Dec19
Southern	Tier 3 Iron	131	8 years	SGN repex - 005 Tier 3So - EJP Dec19
Scotland	Tier 3 Iron	10	22 years	SGN repex - 006 Tier 3Sc - EJP Dec19
Southern	>2" steel + Iron >30m	51	30 years	SGN repex - 007 SteelSo - EJP Dec19
Scotland	>2" steel + Iron >30m	22	13 years	SGN repex - 008 SteelSc - EJP Dec19
Southern	Riser	14	32 years	SGN repex - 009 RisersSo – EJP Dec19
Scotland	Riser	56	12 years	SGN repex - 010 RisersSc - EJP Dec19
Southern	Security	5	12 years	SGN repex - 011 Security So - EJP Dec19
Southern	Security	1	12 years	SGN repex - 012 Security So - EJP Dec19
Scotland	IP Service Reconfiguration	0.2	26 years	SGN repex - 013 IP ServiceSc - EJP Dec19
Southern	Bulk Service Renewals	1.3	25 years	SGN repex – 014 Bulk ServicesSo – EJP Dec 19
Scotland	Bulk Service Renewals	0.3	29 years	SGN repex – 015 Bulk ServicesSc – EJP Dec 19
Grand Total		631.5		

The above table highlights the results of our preferred options in terms of the CBAs we have carried out along with the EJP naming reference. This table shows there is a lot of variance between Southern and Scotland in the CBA payback period, particularly for tier 1 and risers. The variance for tier 1 can be explained through the failure rates being much higher in Southern than in Scotland, as well as there being a higher number of properties affected by failures in Southern compared to Scotland. In terms of the difference shown in the payback period for risers, Southern risers average number of properties fed from risers much larger than Scottish, also the unique physical characteristics of the assets, Scottish risers have proven to have a higher risk profile than those in the south due to internal locations.

Some of our key findings from our EJPs are:

- When looking at the 4R strategy, repex is generally limited to repairing or replacing.
- We have developed additional decision support tools to help us optimise pipe selection, for example Predictive Analytics tool and the service insight tool.
- We have found the vast majority of works we are doing is underpinned by costs that have been fully market tested, for both labour and materials, providing a high level of confidence around these costs.
- Having completed all of this work in our network, there will be much more PE than at the start which is contributing to the pathway to a full range of whole system solutions.

Some of our key findings from our CBAs were:

- Varying results of the payback periods for each asset group.
- The positive environmental benefit from our investment options.

6.6 Investment in new assets

There were a number of things we had considered in our July plan, which are listed below. Having completed acceptability testing and various other stakeholder-based analysis, we do not see a compelling case supported by stakeholders to progress investments in these areas and therefore will not be pursuing these investment options going forward.

Riser remotely operable valves

In recent stakeholder events and customer research we have been exploring the possibility of adapting the isolation valve outside of the building so that it could be remotely operated in the event of an emergency without the necessity of operating manually on site. After thorough engagement with stakeholders, this is not currently included in our core plan.

Methane detectors

Another option we have been exploring with our stakeholders is the possibility of installing methane detectors in the common areas of high-rise multiple occupancy buildings. These offer an opportunity for the early detection of a gas leak in the building before it is noticed and reported as a gas emergency by a member of the public (PRE). The detector can be linked back to our central gas control centre where this early warning of a potential problem could result in one of our first call operatives being dispatched to site to carry out an investigation. After engaging with stakeholders to understand the merits of this option, we have decided not to proceed with this in our core plan.

Hydrogen preparedness valves

We have also considered an enhancement as part of an accelerated programme to insert valves as we continue to replace tier 1 mains. By doing this we are preparing for the possibility of a hydrogen network in the future, by enabling sections of the network to be isolated so that a full hydrogen conversion could be undertaken for areas downstream of that valve. By introducing the valve as a part of the current repex programme it would save the future excavation and installation expenses. We are currently assessing the costs benefit of this approach. There are uncertainties around this approach as we do not know for certain what the future of the network will look like.

6.7 Cost efficiency

As stated in the Cost Efficiency appendix (005), repex equates to approximately 40% of totex.
The long-term nature and the scale of the programme over multiple years as well as the market testing we have undertaken through our procurement processes give us confidence that our unit costs are robust and can be used with confidence as the basis of the allowance allocation for GD2.

Our proposal for GD2 is based on our forecast to 2021 from the RRP unit costs. We have taken this forecast and run it forward to the end of GD2, and while not applying further real price effect uplifts, we have applied an ongoing efficiency assumption of 0.7%/year.

Below we set out the various drivers of our cost efficiency and provide a summary discussion of repex benchmarking, more detail on which is provided in the Cost Efficiency appendix (005).

Comparative efficiency and regional factors

The Totex model shows SGN to be an industry-leading performer over the whole price control across the whole cost base, and the results of the disaggregated repex model should be considered in light of that overall result. Getting accurate comparability is always challenging particularly as the costs are disaggregated away from the macro company level regressions to the individual cost categories, where workload, pricing and overhead allocations can all create significant distortions that restrict the direct comparability of data. The repex benchmarking model is an area where SGN has already proposed a significant number of changes to improve the robustness of the approach via the CAWG, so as to improve the robustness of the approach. We expand on some of the reasons for the current repex results below, please refer to Section 2.3 of the Cost Efficiency appendix (Appendix 005) for detail.

The tables 34,35, below show the relative repex cost efficiency results based on the alternative approach proposed by SGN.

Table 34: SGN Totex proposed methodology

	Standardised efficiency score				
	2013/14	2014/15	2015/16	2016/17	2017/18
EoE	1.04	1.01	1.00	1.05	1.00
Lon	0.90	0.84	0.96	0.99	0.98
NW	1.01	1.16	1.08	1.01	0.97
WM	1.05	1.11	1.05	0.98	1.01
NGN	0.95	0.92	0.94	0.91	0.87
SC	1.00	0.96	0.96	0.98	1.16
SO	1.03	1.03	1.04	1.14	1.05
WWU	1.01	0.98	0.97	0.94	0.95

Since the results of the repex benchmarking are volatile, we show the aggregate/average efficiency scores in the cost efficiency appendix. But for the purposes of comparison to Totex in this section, we show the yearly results.

Table 35: SGN repex aggregate/average – first five years of GD1

	Aggregate model		Average of annual model	
	Efficiency score	Ranking	Efficiency score	Ranking
EoE	1.01	5	1.02	5
Lon	0.97	2	0.93	2
NW	1.00	4	1.04	7
WM	1.02	6	1.04	6
NGN	0.92	1	0.92	1
SC	1.03	7	1.01	4
SO	1.07	8	1.06	8
WWU	0.98	3	0.97	3

Given the concerns that we have with regards the robustness of the approach, the use of a single year can be particularly misleading. The results from Ofgem's benchmarking models suggest that in 2017/18 SGN was the weakest performer on repex efficiency. However, as noted in our 25 March paper, these results are particularly volatile from year to year. For example:

- Between 2013/14 and 2015/16, London's efficiency score swung from 0.92 down to 0.83 in one year, and then back up to 0.95 the year after.
- The score for one GDN spiked to 1.16 in 2014/15 before falling back to below average by 2016/17.
- SGN Southern and Scotland both exhibit similar spikes, in 2016/17 and 2017/18 respectively.
- In all years of GD1, except 2017/18, SGN Scotland's performance is approximately equal to the sector average – it is only in the last year that the results for Scotland deteriorate (a similar observation holds for Southern as well).

Given that the current repex regressions are fundamentally a comparison of unit costs, we do not believe that it is credible that these very large and rapid swings in efficiency scores could reflect genuine changes in efficiency performance year-on-year. As referenced in the Cost Efficiency appendix (Appendix 005), there are a few proposals we recommend Ofgem take on board for repex in relation to benchmarking, summarised below:

- Aggregating cost and workload, and running a single regression or averaging efficiency scores over five years;
- Adjusting for efficient and safe processes that do not result in mains laid (e.g. CISBOT);
- Assessing large diameter pipes outside the regression model; and
- Assessing efficiency versus quality of service (see sub-section below).

Regional factors, as stated in section 3.4 of the Cost efficiency appendix (Appendix 005), is something that is predominantly driven outside of our control, some of the key pressures we face through regional factors are:

- London-specific costs;
- Sparsity costs in Scotland;
- Costs associated with operating on the Isle of Wight; and

- Other sources of regional costs.

These are each individually discussed in detail in the Cost Efficiency appendix (Appendix 005) however when looking at repex specifically, the above are all applicable factors. The two most material factors are London-specific costs for Southern and sparsity for Scotland.

There is much more of a challenge when it comes to the delivery of repex in the South East region due to the London zones SGN covers and the cost associated with those zones which drive up unit costs, as well as the climbing contractor rates we have seen in these areas. A study undertaken by NERA and Arcadis on regional cost analysis suggests that our Southern network incurs £30m/yearly in 2018/19 prices due to regional factors outside of our control. These factors cover:

- Regional labour costs (£18.2m yearly)
- The nature of streets and other factors which relate to the physical make-up of the network surroundings (e.g. more expensive footpath materials which drive reinstatement costs) (£11.5m yearly)

Both these factors fully apply to replacement works. More justification and detail are provided in the Cost Efficiency appendix (Appendix 005) and in the study by NERA and Arcadis.

In contrast, there is also a challenge in the delivery of our Scotland regions due to the sparsity of pipes and the cost associated with this to meet emergency standards. We have updated the analysis Deloitte undertook for Ofgem for GD1, using the same methodology, with our latest data for each depot on employee numbers (full-time equivalent), number of emergency and repair jobs per year, and labour rates. We have estimated sparsity-related costs for Scotland of £3.4m yearly in 2018/19 prices (equivalent to £2.6m in 2010/11 prices). This is a slight increase from the sparsity estimate of £2.3m Deloitte calculated in 2011 (in 2010/11 prices).

Cost pressures and real price effects

We have seen significant cost pressures in GD1, particularly with respect to contractor rates, which we have partially been able to offset with innovation as set out further down in this section. As the unit costs we use for GD2 are based on our RRP unit cost forecasts as of the end of GD1 (2020/21) and an additional efficiency of 0.7%/year, we have not baked further cost pressures into them beyond what is already included in GD1.

To estimate our 2020/21 RRP unit costs for Scotland, we have simply rolled forward the 2018/19 values in real terms as we do not expect further cost pressures until the end of GD1.

For Southern, we have applied further cost pressures to the 2018/19 RRP unit costs until 2020/21 based on the contract extensions that we procured in 2018 to ensure the delivery the GD1 programme, following other contractors leaving the market due to insolvency/liquidation or uncompetitive rates. The real annual growth rates applied to the 2018/19 RRP unit costs for Southern are set out in the table 36 below.

Table 36: Forecast average lay unit cost annual growth (real) – Southern

	2019/20	2020/21
Tier 1	3.5%	1.1%
Tier 2/3	7.0%	2.1%

The analysis of our repex cost pressures is summarised in this section and covered further in the following locations, which should be read in conjunction to give a full picture of cost efficiency for repex:

- External review of contractor rates by Hargreaves Jones and an internal assessment in section 3.5 of the Cost Efficiency appendix (005);
- Assessment of the competitive tendering framework for repex as summarised in the competition section 6.9 in this appendix and detailed in the Procurement and Native Competition appendix (010); and
- Assessment of contractor cost as well as material and direct labour cost increases compared to inflation as set out in the RPE section 6.10 in this appendix and detailed in section 3.5 in the Cost Efficiency appendix (005).

As shown in the table 37 below, contractor costs make up c. 70% of repex, so cost pressures in the contractor space have the most material impact on our repex efficiency. Materials and direct labour cost pressures are discussed in the RPE section 6.10 of this appendix.

Table 37: Summary of Historical RPEs applicable to repex

	Percentage of repex Costs	Annual Growth in Costs	CPIH
Contracted Labour	71%	5.06%	.54%
Materials	17%	4.10%	
Direct Labour	12%	2.57%	

In section 5.5 of the Cost Efficiency appendix (005) there are detailed results of a review carried out by Hargreaves Jones [18]on our individual contractor rates. Its analysis of SGN repex contracts focussed on selected representative contractors and specific rates that were considered to be appropriate for the analysis, based on the number of contracts available and the amount of work being undertaken by each contractor, to summarise what they found:

- SGN has experienced substantial contractor cost pressures: "While there were significant inconsistencies between all contractors in terms of price movement over the period against individual types of work, prices generally appear to have increased in the range of 10% to in excess of 50%".
- These cost pressures have outstripped CPIH, table 1 of the Hargreaves Jones report details an actual RPI increase of in the order of 15% since 2013 and this analysis indicates that the movement in contractor prices for specific work types has been to varying degrees in excess of this index."

Furthermore, the review of 115 rate changes in contracts shows that 83 contract rates (72% of the total) have

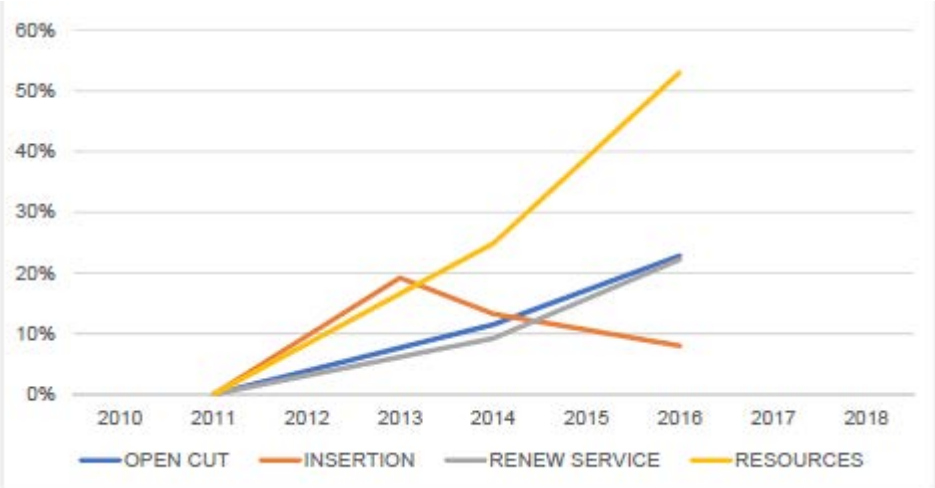
[18] *Hargreaves Jones SGN GD2 Procurement Strategy – Review of Inflation Indices and Impact on Existing SGN Contracts, August 2019*

experienced rate increases above CPIH over the total contract period. The breakdown by rate category is as follows:

- Of 20 open cut contract rates, 15 (75%) have had rate increases above CPIH;
- Of 54 insertion contract rates, 35 (65%) have had rate increases above CPIH;
- Of 19 renew services contract rates, all (100%) have had rate increases above CPIH; and
- Of 22 resource contract rates, 14 (64%) have had rate increases above CPIH.

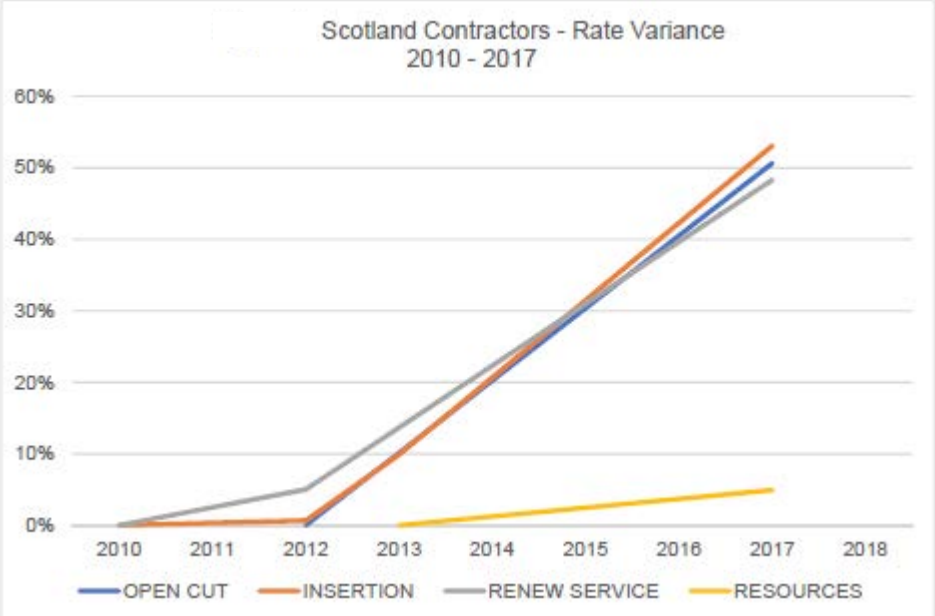
The rate increases have been driven by market conditions, with the rates for some types of work increasing up to 55% in nominal terms from 2011 to 2017. This would compare to RPI growth of 15% over the same period. The two graphs below show a comparison of nominal variances in contractor rates from 2011.

Figure 23. Southern England contractors – ate variance 2011-2016



The analysis indicates that across all rate bands for technique or resource contracted rates, the rates have increased significantly in the order of 7% to 53%.

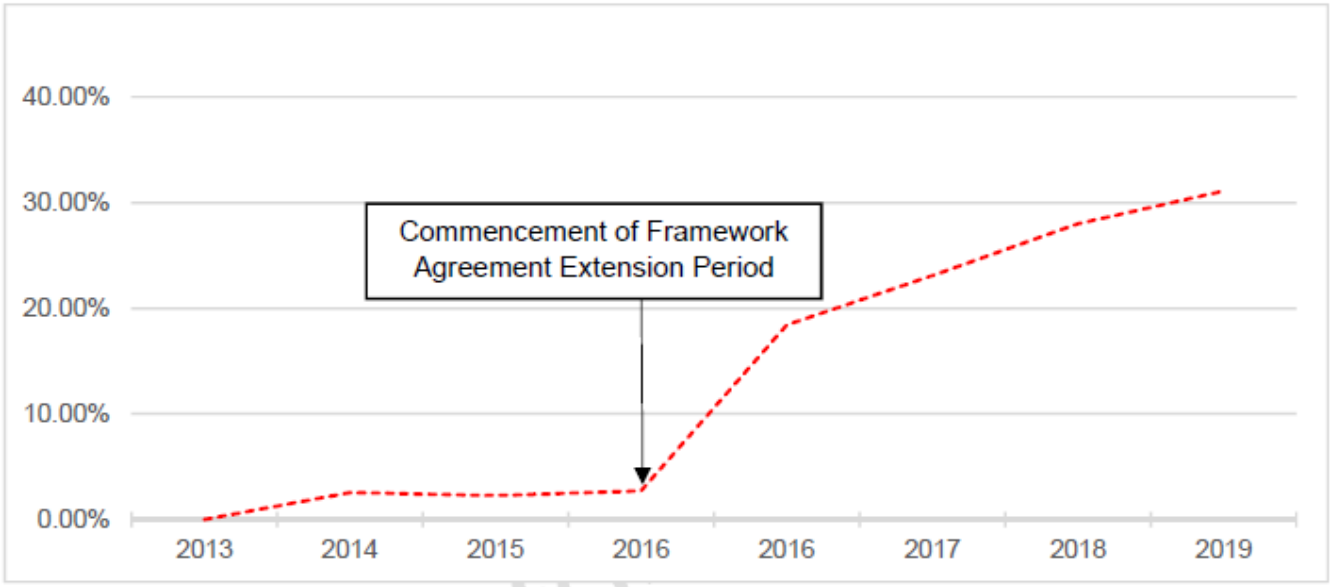
Figure 24. Scotland contractors rate variances



The analysis indicates that across all rate bands for technique or resource contracted rates, the rates have increased significantly in the order of 1% to 55%.

Contractor pressures jumped significantly in October 2016 when the Southern repex programme went through a full procurement process. The graph below shows the aggregate increase for an average package, including inflation, indicating that contractor rates jumped by 15% in October 2016 with a further annual increase of 4% in the next two years and another 2.4% in 2018/19.

Figure 25. All lots average – package cost increase from 2013 (%)



Section 6.9 in this appendix describes the competitive procurement process we have gone through to appoint the

repex contractors throughout GD1 and particularly the limitations of the market pool that gave contractors bargaining power during the retendering that led to the rates increase in 2016/17. It contains more detail on cost pressures and ways we have adapted our procurement strategy to maximise competition to ensure cost efficient delivery, while maintaining safety and customer satisfaction.

Please refer to section 6.10 in this appendix for more detail on the RPEs.

Efficiencies included in the repex plan

All the efficiencies we have achieved in GD1 are baked into our GD2 unit costs as we have been able to deploy them in business as usual mode. The table 38 below shows the top five innovation projects from GD1 with the savings they have driven. Further details can be found in sections 3.8 and 6.5 of our Innovation appendix (008).

Table 38:

Innovation	repex savings (£m/year)
Live mains insertion (downsize live)	£4.82m
20mm Serviflex for 1 ¼" steel service	£3.12m
29mm Mains Insertion Camera	£2.38m
Large CISBOT (Cast Iron Joint Sealing Robot)	£2.71m
Wask PE Riser System III	£0.98m

Benefits realised from these innovations are fully embedded into our current unit costs which have been used as the basis for developing our GD2 forecast together with additional productivity improvements throughout GD2.

In terms of efficiency with our contracting strategy, predominantly all our work is undertaken in Replacement by external contractors who have competitively tendered for the work, however we also utilise direct labour teams, particularly in the summer months e.g. utilisation of repair teams when work on emergency and repair is lower during the summer months and we are able to repurpose those workers as they are cross trained to also do mains replacement works. What this enables us to do while using our direct labour teams is flex our contract workforce and requirements according to the availability of the direct labour teams.

We have challenged suppliers to identify further innovation techniques in Replacement, but the extent has been limited. In 2018, we challenged two leading repex innovation companies to bring to us new solutions. This resulted in an exhibition of eight manufacturers where they showcased innovative approach that can be used in replacement. We are taking one of these forward (stent bag). We did not identify any which would deliver material savings.

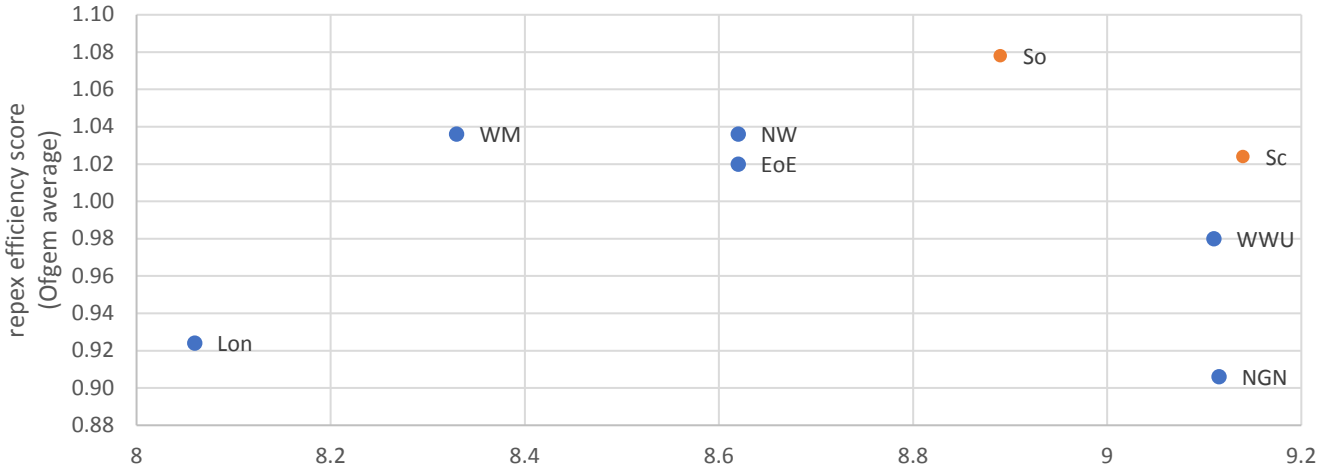
In repex we have implemented a further 0.7% (£4.9m per annum) of ongoing cost efficiency for GD2, on top of GD1 efficiencies, which is higher than the bank of England latest forecast of economy wide productivity in the UK of 0.3%. Further detail on this is provided in section 3.3 of the Cost Efficiency appendix (005).

Service level provided for costs

Finally, we consider it is important that the benchmarking results are evaluated alongside a sense check of the quality of service provided by the GDNs to assess cost efficiency. It would be expected that there is a link between cost and quality – so if GDNs were failing to meet quality standards/targets, it would be inappropriate for those GDNs to also be informing the cost upper quartile and therefore setting the cost target for other GDNs which are providing better service quality.

To illustrate this additional factor, we present various quality drivers against the repex efficiency score below to give further evidence to the nuances in repex efficiency scores.

Figure 26. Customer satisfaction plotted against efficiency score (GD1 Average)



As shown above in figure 26, both Southern and Scotland (SGN Networks) have achieved and maintained high customer satisfaction scores in GD1, albeit at a slightly higher efficiency score. In comparison to other networks the service we have provided is proven to be valuable in contrast to other GDNs that show a higher efficiency score but with their customer satisfaction scores are the lowest.

Figure 27.Number of planned interruptions per km decommissioned (GD1 average)

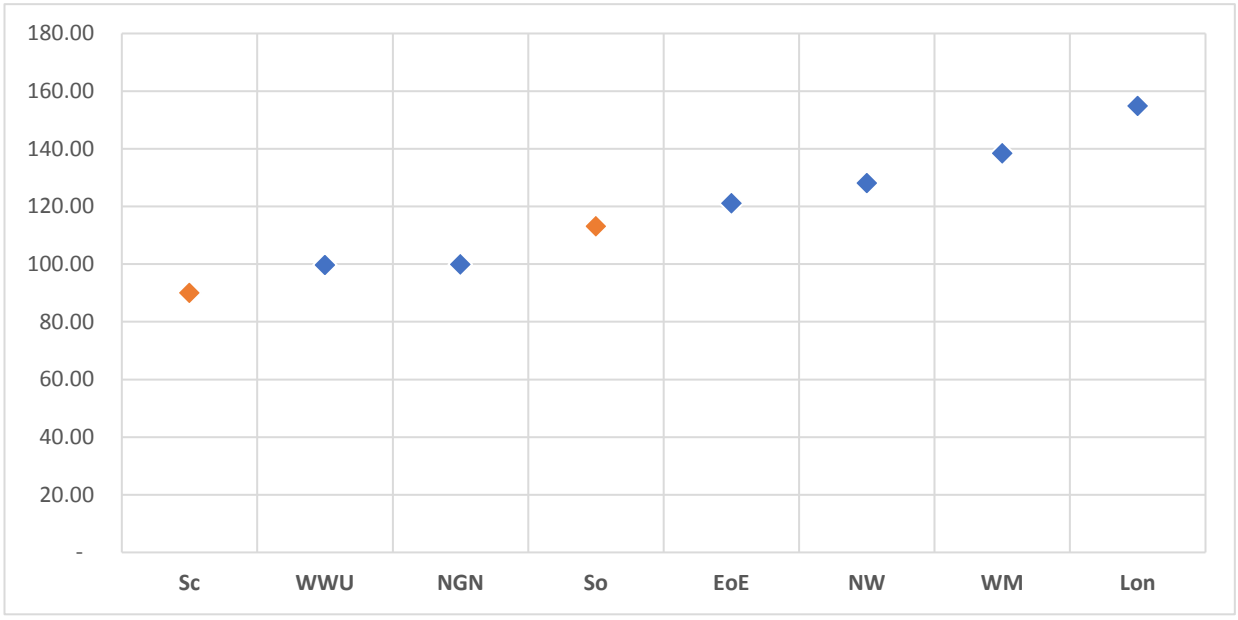


Figure 27 demonstrates that SGN, over a 6-year average, has the lowest levels of planned interruptions in Scotland and fourth lowest levels in Southern when compared against the length decommissioned on a GD1

average. As mentioned in section 3.3 of this appendix we have, over the course of GD1, utilised techniques such as live insertion which has enabled us to minimise the amount of planned interruptions to customers. This is also a contributing factor to the positive results for SGN seen in figure 26 as by minimising the number of interruptions to the customer they are more satisfied with the service we provide.

6.8 Managing uncertainty: use-it-or-lose-it, volume drivers and reopeners

There are several uncertainties around repex that have been identified for GD2, including increasing traffic management costs, TSA Scotland/TMA Southern, lane rental charges and potential changes to statutory instruments on stubs, tier 2a, <=2" steel or any other legislative change. Uncertainty mechanisms are an important way for us to balance risk between our company, our customers and stakeholders. Where the future workload or requirement is unclear, and we have limited control on the outturn, we can consider using one of Ofgem's designated uncertainty mechanisms; either a volume driver, a use-it-or-lose-it allowance or a reopener.

We propose five mechanisms to manage repex uncertainty over GD2 for:

- Tier 1 iron stubs
- Tier 2a iron pipes
- <=2" steel
- Streetworks
- Significant legislative/regulatory change

Listed below are the mechanisms we are proposing to manage the uncertainty around the five areas and the potential costs associated with each of them.

Table 39: repex uncertainty mechanisms summary

Uncertainty Mechanism	GD2 estimated annual cost (£m/year)		Uncertainty mechanism type
	Scotland	Southern	
Bespoke uncertainty mechanism: Tier 1 iron stubs – use-it-or-lose-it	£0.39m/year*	£0.99m/year*	Us- it-or-lose-it
Sector uncertainty mechanism: Tier 2A (mains and services) volume driver	£0.32m/year*	£1.88m/year*	Volume driver
Bespoke uncertainty mechanism: <=2" steel (mains only) volume driver	£1.82m/year*	£3.88m/year*	Volume driver
Sector uncertainty mechanisms: Streetworks	£6.0m/year	£7.0m/year	Reopener
Sector uncertainty mechanisms: Hazardous waste	£0.5m/year	£0.8m/year	Reopener
Legislative/Regulatory Change (reopener)	Unquantified		Reopener

* Excludes overheads.

Tier 1 iron stubs (use-it-or-lose-it)

Stubs are short lengths of small diameter iron tier 1 pipe connected to the larger tier 2 and 3 mains. Prior to GD1, we were working to a programme to replace all iron within 30m of a property by March 2032, regardless of whether it was tier 1, 2 or 3. At the start of GD1, the HSE policy changed so that the tier 2 and tier 3 were no longer considered mandatory, and their removal was to be determined according to an assessment of risk and

condition of the pipe and subject to cost benefit analysis. Without a mandatory requirement to replace tier 2 and tier 3, there is no natural driver to decommission these stubs.

We are currently in discussion with the HSE regarding the best approach to managing these stubs with other GDNs. We have proposed to the HSE to declassify them as tier 1 iron pipes, thus removing them from the IMRRP, and reclassify them as tee-piece assemblies forming part of the large diameter tier 2 or tier 3 iron mains. The proposal was based on a piece of work that the GDNs have jointly commissioned with DNV GL to complete a risk assessment for these stubs. The report now completed has been submitted to the HSE for consideration and we are currently awaiting their initial response. This is a national issue that would affect all GDNs.

If the HSE approves our proposals, we would not have to replace these stubs in GD2. We do not anticipate an HSE decision in time for our final GD2 Business Plan submission. To protect customers from the risk of committing to deliver this requirement, which may be removed, we propose a PCD where the allowances in GD2 are adjusted according to the HSE's eventual decision. In section 12.2.3 of the Business Plan we have proposed a use-it-or-lose-it allowance to accompany this output. The uncertainty mechanism will be triggered by the HSE's decision. If the HSE approves our proposal to declassify the stubs, then the equivalent GD2 allowances can be clawed back through an end of period adjustment, and the remaining stubs can be targeted in GD3.

For our use-it-or-lose-it allowance, we have currently included £1.7m/year in our BPDT for tier 1 stubs as a precaution in case the HSE do not grant an exemption and the work needs to be delivered. From our asset records we are aware of 1,625 iron stubs (1,094 in Southern and 531 in Scotland). This may be an underestimate as records dating back to when mains replacement was underway in the 1970s are less reliable. In GD2, we plan to decommission/replace 711 in Southern and 345 in Scotland of these at a cost of £8.7m, at an average lay unit cost of £8,411/stub for Southern and £7,885/stub for Scotland (£1.7m/year). This is based on delivering 65% of the stubs in GD2 and the remaining 35% in GD3. In GD1 there was no comparable output measure or workload.

We think that there are innovative techniques which, if developed further, could reduce the associated costs of managing these assets significantly. An example of one relevant innovation is the NIA funded seal back.

Tier 2a iron pipes (volume driver)

The uncertainty risk associated with tier 2a iron pipes is that these pipes have dynamic risk scores and become mandatory to replace within 12 months of discovery if they breach the risk score thresholds. As mentioned in section 6.2 under tier 2a iron pipes based on the unpredictable workload we see for these pipes, it is appropriate to continue with the current sector mechanism for tier 2A iron pipes by using a volume driver to cover these projects. We foresee that these are likely to be relatively low volume activities which we have forecasted in our plan based upon historical evidence.

To implement a volume driver as a mechanism for managing uncertainty we are proposing that the existing arrangements currently used in GD1 should remain in place for GD2, as per Ofgem's Sector Specific Methodology Decision of May 2019. Historically, annual dynamic growth has accounted for 0.5km/year for Scotland and 2.7km/year for Southern. On that basis, over the course of GD2 we would expect to complete 16km of tier 2a pipe.

We propose a volume driver using the average lay unit costs below. We would true-up volumes and related costs at the end of each year to be recovered in the following year.

Table 40: Average lay unit costs from BPDT for tier 2a volume driver (2018/19 prices)

Diameter	Scotland – £/m	Southern – £/m
9"	449.06	709.99
10" to 12"	722.89	686.83
>12" to 17"	986.72	888.80

Note: All unit costs exclude overheads.

<= 2" steel (volume driver)

When we discover <=2" steel pipes we are mandated to decommission them as soon as possible. These steel pipes are highly localised and specific to geographical areas, in part due to the construction preference at the time of installation. Our records are limited but do indicate that a higher density of <=2" steel is in areas such as Glasgow, Dundee and the south coast of England. Part of the uncertainty arises from that in GD1 we have moved our replacement programme from areas of high density to areas of low density of <=2" steel. In GD2 our replacement programme will move back into areas that our records show we have greater density of <=2" steel. We expect that we will see an increase in the volumes that we would have to replace in GD2, compared to GD1.

Figure 28. Scotland records

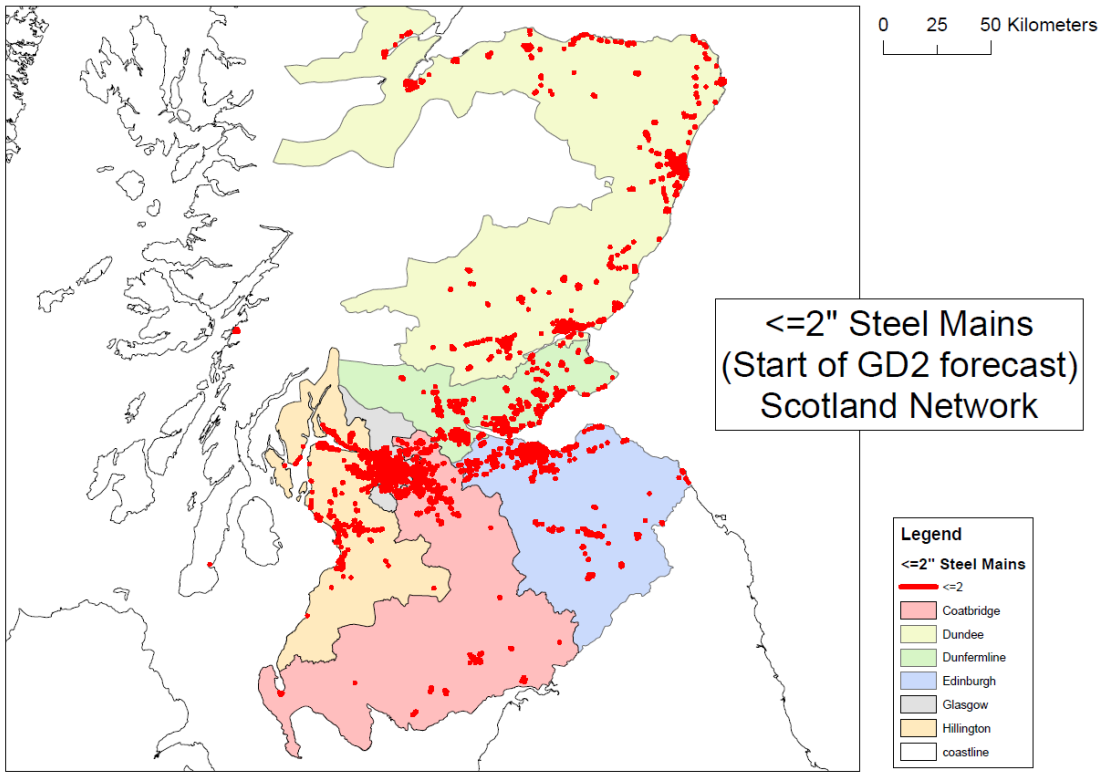
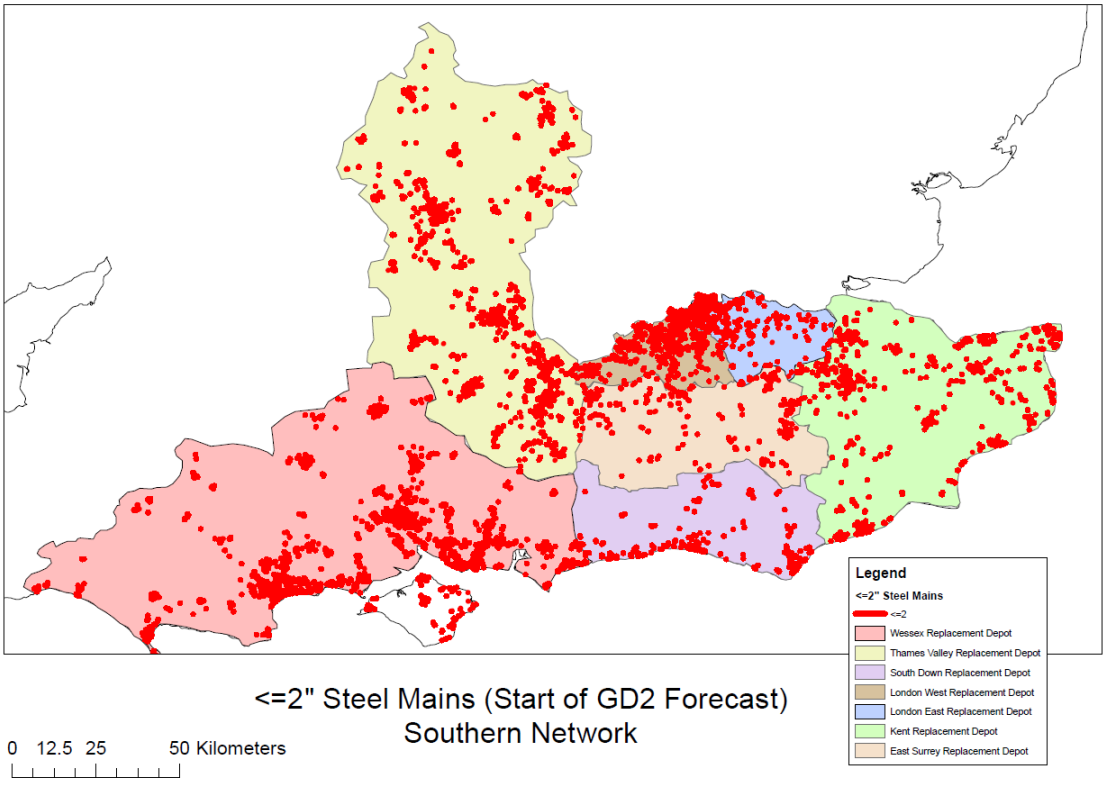


Figure 29. Southern records



However, although we have some records, a large proportion of the population of <=2" steel is unrecorded as these small diameter pipes were installed 50 to 60 years ago and inconsistently recorded across all GDNs. We therefore have limited visibility of the amount of mandatory replacement we would have to undertake and risk over or underestimating it if we only base it on the records we have.

To protect customers from this uncertainty, we propose a volume driver mechanism. In the first six years of GD1 we have seen a decrease in <=2" steel from 59km per annum to 47km per annum. We have assumed the run rate of 49.6km per annum in GD2 at a cost of £7.2m total for Scotland and Southern. As a sensitivity, based on our asset models and the pipe locations for our remaining population of <=2" steel, correlated with our remaining tier 1 pipe population, we are anticipating that the actual work we will need to complete may go over and above the run rate up to 60 km per annum, increasing the GD2 cost by £1.5m/year.

We therefore propose a volume driver as described in section 12.2.4 of the Business Plan, using the average lay unit costs below. We would true up volumes and related costs at the end of each year to be recovered in the following year.

Table 41: Average lay unit costs from BPDT for <=2" volume driver

	Scotland – £/m	Southern – £/m
Average lay unit cost	85.08	195.57

Note: All costs exclude overheads.

Without a volume driver, our customers may pay for work that may not be required or alternatively SGN could be in a position that there is no funding to carry out this work. Other types of uncertainty mechanisms would not be appropriate as we know we will have to undertake this work and what is unclear is the quantum.

Streetworks (sector-wide reopener)

We have proposed a single reopener for street works in general that covers three specific areas of uncertainty set-out below: permitting and lane rental, clean air zones, and hazardous waste management. We anticipate this would operate as a single reopener to capture all three in 2023/24.

Our replacement activities often require us to work on gas mains that are situated underneath or close to the public highway (section 16.2). Traffic management is subject to different legislative requirements in our Scotland and Southern regions. In Scotland many aspects associated with road works are devolved to the Scottish Parliament and oversight from the Scottish Road Works Commissioner is provided to monitor performance around planning, co-ordination and co-operation. In Southern, decisions are decentralised and vary across each local authority. The Traffic Management Act 2004 (TMA) established a permit scheme as an alternative to the notification system which existed under the New Roads and Street Work Act 1991 (NRSWA), designed to help local authorities minimise the disruption caused by street works.

The notification system was used by companies to inform an authority about their intention to carry out works on the local highway. Under the permit scheme, companies must apply for a permit to work in the area, which would include any restrictions imposed by the local authority. TMA only applies in our Southern network area.

In our Southern network, lane rental has been piloted on the most traffic sensitive areas of London (TfL) and Kent to monitor the impact of a £2,500 daily charge on disruption to road users caused by street works. A number of local authorities in our Southern region have already indicated their intent to apply the charges, but it is unclear how they will be applied, when they will be introduced and what the charge will be.

The Transport (Scotland) Bill was passed on 10 October 2019. The bill addresses roadworks and low emission zones, two areas that will have implications for how we plan and undertake necessary planned or unplanned work on network assets in Scotland. For low emission zones, rather than address the specifics of enforcement and penalties, the bill allows Scottish Ministers the powers to make regulations specifying emissions standards, exempt vehicles, the amount of any penalty charge and other detailed aspects of schemes in operation. For road works, increased enforcement powers, increased quality control and specified notification timescales have been introduced. At this stage, the cost impact of the bill is uncertain and not likely to be fully realised until that start of GD2.

Given the uncertainty around how our costs and operations may be impacted as street works legislation evolves and is applied, we have included the anticipated cost for London and Kent within our baseline allowances and propose a reopener structure through which an updated position can be assessed midway through the GD2 price control. We think that this structure provides the right balance of risk as it enables the existing London and Kent schemes to act as a benchmark from which other regions are assessed, while maintain an appropriate incentive to minimise our cost exposure.

Potential events that would trigger the reopener would be:

- Scotland – legislation
- Southern – any other councils putting in place lane rental schemes

We estimate if these events occur, they may trigger circa £7m/year for Southern and £6m/year for Scotland.

Hazardous waste management

At the time of writing our business plan and associated appendices, there is an Environment Agency Regulatory Position Statement (RPS 211) in place. This regulatory position statement (RPS) applies to businesses who deal with excavated waste from unplanned utilities installation and repair works, and applies to businesses, such as ours, who produce excavated waste. The RPS allows excavated waste which has not been assessed and classified in line with the hazardous waste technical guidance[19] to be classified as non-hazardous waste.

The Environment Agency has expressed its intention to withdraw RPS 211 in 2020. The original withdrawal date was intended to be April 2019; however, this was changed due to the industry wide uncertainty surrounding the practical requirements needed to address this issue.

There is currently a pilot assessment in place within the utilities industry with the aim of gaining a greater understanding of the baseline and how waste can be practicably assessed and classified in unplanned operations. With guidance from the Environment Agency a uniform strategy was developed for the study to which there has been circa 600 sample results to date. The sampling trial is now in the second phase with an increased emphasis on comparing the relationship between the make-up of the and ground hazardous classification.

A collaborative review of the trial data will take place in November 2019 allowing the industry to discuss the findings. Conclusions from the research will support the development of the waste classification protocol and provide a justification for an assessment of risk associated with utilities excavation arisings.

The Environment Agency has agreed that the scope of the protocol will apply to all excavation wastes borne from construction activities on below ground utilities assets.

Current discussions across the industry suggest that a documented, risk assessment approach for classification would be the basis of the protocol. The level of detail required for the risk assessment would be scaled on the type of utilities activity and provide strict definitions as to when chemical analysis would be required.

As there is currently no drafted protocol and the full details of the trials and associated data is not available for analysis, the industry is uncertain of the costs associated with this new protocol. Therefore, as part of this business plan submission we are proposing to introduce a reopener mechanism to adjust our prescribed allowances, should the amount of hazardous waste found on our networks exceed 1%.

A draft protocol will be available for review mid-December 2019 and in late January 2020 will be presented to a table of industry peers for discussion and agreement. The submission deadline for the draft protocol to the regulators is the February 2020.

Further information on the uncertainty of managing waste can be found in our Environmental Action Plan (EAP) (003) and section 12 of our main business plan

[19] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/719394/Waste-classification-technical-guidance-WM3.pdf

Legislative/regulatory change (reopener)

We have a primary duty to ensure that our pipeline systems are designed and operated to ensure security and reliability of keeping the gas flowing to all our 5.9 million customers during the most severe of winter conditions when gas demands are at their highest. Contained within the Health and Safety at Work etc Act 1974[20] are the Pipelines Safety Regulations 1996[21]; and Pressure Systems Safety Regulations 2000 (PSSR)[22] which cover the safe design, construction and use of pipelines and pressure systems any change to these statutes would require a trigger to allow our compliance as duty holders to be maintained.

Any material changes in the HSE's enforcement policy for the IMRRP, or additional HSE requirements not yet identified (e.g. risers) should also be subject to an uncertainty mechanism which could be triggered at any point in GD2.

Our view now is if HSE policy changed and the consequence is we would need to spend more money on the programme, we would expect that to be fully funded by customers. The reason for that is because the low cost of equity proposed by Ofgem does not encourage companies to bare any risk. With a high cost of equity, we may consider baring some risk but at the moment we see uncertainty mechanisms covering anything that could happen to us as a business.

We propose a trigger threshold of £10m in GD2.

20 https://www.gkstill.com/Support/Links/Documents/2006-hse.pdf
21 http://www.hse.gov.uk/PuBns/priced/l82.pdf
22 http://www.hse.gov.uk/pUbns/priced/l122.pdf

6.9 Competition

As set out in section 6.7 of this appendix, our GD2 unit costs are based on our end of GD1 unit costs (with an additional ongoing efficiency applied). In this section we set out the competitive process that our repex programme delivery has gone through to produce these efficient costs used in the GD2 Business Plan. The majority of repex work is competitively tendered with 70% weight on price and 30% weight on quality and safety in the tender assessment.

As detailed in our Procurement and Native Competition appendix (Appendix 010), throughout GD1 we have demonstrated a strong process to obtain interest from contractors and maintain stable contracts. In order to do so we implemented strategies such as splitting packages of work into various geographical areas to encourage the market and allow both regional and national contractors to compete and drive competition and introducing incentives based on target delivery. Due to diversity in requirements and various geographical challenges within both Scotland and Southern regions, separate contracting strategies exist for Southern and Scotland.

In order to drive efficiency, value for money and improved performance, in the beginning of GD1 it was agreed that the EPC contracting model where 95% of Southern repex workloads were outsourced to a sole contract was not best suited to meet the challenges ahead. In addition, the following challenges and aspirations were behind a change in strategy:

- In the South, an over reliance on a single supplier who was commercially aggressive and failing to meet performance standards and targets was a high risk. Lack of alternative contractors put SGN at risk of not meeting performance and programme requirements.
- Potential to work more collaboratively with smaller suppliers enabling higher performance standards
- Requirement for more cost competitive delivery
- Desire to obtain value from quicker responses to innovation and improvement on performance issues due to a more responsive contractor with less hierarchical barriers
- Stimulate market to obtain competition as larger contractors were focussing on other industries with higher rates and lower risk

The current contracting strategy for GD1 is built on a series of framework agreements that we expect to build on as an appropriate way for delivering value for money during GD2. In 2016, we retendered all repex contracts in Southern, moving towards medium-sized suppliers due to the increase in technical and safety requirements.

In the latter years of GD1 and leading up to GD2, market conditions became extremely challenging to secure contractors to deliver the repex programme. The market for mains replacement has become very competitive and we have adapted our strategy to provide value for money by keeping price increases low, while maintaining safety.

Competitively tendered rates

As set out in section 6.7 in this appendix, contractor rates went up by 15% in 2016. Those rates reflect a full procurement process in Southern, in which price had a 70% weight and health and safety were a pass/fail requirement. Scotland contracts were retendered in 2017 and 2018. The tables 42,43, below show the procurement process milestones and the number of parties at each stage as well as the number of contractors we have retained as of 2019. In Southern, the repex packages were based on five-year contracts (two plus three extension) and an extension event was run in 2018. We saw hikes in rates in both events, which we explain below.

Table 42: Scotland

Year	Package	£m procured	Supplier EOI	Supplier Submissions	Supplier Awards	Active at End of FW	Duration (years)
2013 – 2014	Mains Replacement Framework	£10–12m pa	14	10	5	1	
2014 – 2017	SGN Mains repex Scotland	£10–12m pa	27	14	10	4	
2014 – 2018	SGN Reinstatement Scotland	£4–5m pa	9	7	1	1	
2017 – 2020	Dundee Depot	£5–6m pa	2	1	1	Currently 1	3+2
2017 – 2020	Mains and Service Operations	£12–14m pa	8	8	7	Currently 6	3+2
2017 – 2021	Large Diameter	£3–4m pa	2	2	1	Currently 1	4+1
2018 v 2023	SGN Reinstatement (repex)	£5–6m pa	28	21	5	4	3+2

Table 43: Southern

Year	Package	£m procured	Supplier Submissions	Supplier Awards	Active at End of FW	Duration (years)
2016	Southern Tier 1	£70–90m pa	14	11	Currently 8	2+1+1+1
2016	Southern Tier 2	£20–25m pa	2	2	Currently 2	2+1+1+1
2017	Tier 1 (Oxford) – One off	£2–3m	2	1	1	N/A
2017	Tier 1 (Kent) – One off	£3–4m	3	1	1	N/A
2018 to 2019	Tier 1 (Various) – One off	£30–40m	14	9	Currently 8	N/A

In our procurement process for Southern tier 1 package in 2016, we started with 253 potential bidders on Achilles. Eighteen of them submitted PQQs and four dropped out after the PQQ, which left 14 that submitted ITTs. In that procurement process, we had introduced new requirements, e.g. the new Construction (Design and Management) or CDM and that contractors need to provide their own safety management, this applies to all frameworks. We awarded contracts to 11 suppliers. Three of the smaller incumbent contractors failed to secure works mainly due to the new requirements under CDM and inflated commercial submissions.

Tier 2 was a new package of more complex work that was tendered for the first time in Southern in 2016 and gathered limited interest as suppliers had to meet more stringent requirements for such major projects.

Reduced market interest and cost pressures

We have seen a shortage of repex-compliant suppliers in Great Britain since 2016. This is evidenced by the constantly shrinking pool of qualified contractors for high-risk jobs such as replacement. During this time, out of our 31 original suppliers for Southern:

- Eight suppliers went bankrupt;
- Seven did not retender for extensions in 2018; and
- Five left the framework before the end of the contract because of more attractive rates in other sectors (e.g. one went to the water sector, others went into fibre) or higher rates offered by other GDNs.

We have seen some suppliers entering from outside the GB market, for example, from Ireland and Northern Ireland. However, the market for contract labour is still very competitive, which gives suppliers bargaining power and limits our ability to drive down costs. Keeping costs efficient is still our key objective, as we secure the best value for money delivery for our customers. That is why during the extension negotiations in 2018 and when suppliers were shifting to other clients because of price, we did not enter a price war and still retain a 70% weight on price in our tenders.

Contractors that have transferable skills have chosen to move away from repex jobs because they have opted for jobs with lower risk (no live gas pipes) and more lucrative rates, such as water, electricity and even fibre. Below we set out a few examples of factors that affect the competitiveness of the contractor market. Annex B in the Procurement and Native Competition appendix (Appendix 010) analyses the full range of factors.

We do not award contracts based on price alone. A considerable emphasis is placed on quality and safety when evaluating tender submissions. For instance, SHE compliance is a mandatory element which contractors must meet and adhere to. Suppliers must deliver an average score of 75% across all non-price categories – Health, Safety, Environment, Quality and Corporate Social Responsibility – to meet the minimum standard for tender event. For certain works, we have an additional SHE requirement. For example, in 2015 we raised our requirement for scaffolding to included membership of the National Access and Scaffolding Confederation (NASC) membership. This approach resulted in six out of the top 10 incumbent suppliers requiring an upgrade to their technical portfolio before they could bid for works. Contractors are aware of the high expectations surrounding SHE and tend to bring in a dedicated SHE Manager/resource to oversee this element of the works, which increases their costs. We have also seen three contractors fail to meet the minimum technical criteria (one if Southern, two in Scotland).

Furthermore, extensive IGT activity on new connections around 2016 resulted in a shift of suppliers from replacement into connections. Compared to IGT type of work, repex programmes have higher requirements for governance, qualifications, customer score, as well as increased health and safety criteria and performance management, as set out above. Contractors tend to reflect this higher risk in higher rates or opt for IGT work if we are unwilling to accept their rate increases.

As mains replacement works carry medium/high risk, SGN demand that appropriate insurance certificates at specific levels are in place for all contractors. However, some contractors will not have this level of insurance and will have to build the costs into their rates.

Recent movement of labour from the gas industry to specifically the fibre optic roll-out has had a detrimental effect on programme delivery risk. It also results in a lapse of gas accreditations which impacts the entire gas industry with the loss of competent workers. The move in the other direction from water, electricity and fibre into gas is more difficult as additional qualifications are required.

The combination of the factors above has reduced contractor competition in the gas market and has increased the contractors' bargaining power compared to pre-2016. We have seen significant variation in prices bid into our repex frameworks. Below we show examples for Southern packages, which shows the evolution of bidder price variances:

- 2017 tier 1 iron packages (Oxford) – c. 3% from lowest to highest
- 2017 tier 1 iron package (Kent) – c. 20% from lowest to highest
- 2018 tier 1 iron packages (Various) – c. 100% from lowest to highest

In Southern we receive significantly different costs for each tender event. Incumbent contractors' bids vary dependant on current workloads. New contractors generally apply caution which has resulted in bids in excess of 100% above our benchmarked rates.

More detail on this can be found in the and Procurement and Native Competition appendix (Appendix 010) in the Overview of repex section.

Mitigations

Section 3.3 in the Procurement and Native Competition appendix (Appendix 010), details the mitigative actions such as incentives and other showing how we use incentives to drive the correct behaviours across the contractor base. Some examples are set out below.

We are in the process of developing and trialling a target cost approach where risk and reward is shared with the contractor depending on final cost output of a project. The level of pain/gain will be calculated against a pre-agreed target cost and incentivises the contractor to deliver at the most cost effective and efficient way to maximise their gain share. We have just begun this process and will be trialling it with three suppliers in Southern.

We are keen to increase and improve the number of quality contractors within the gas industry. Recent tenders which have been made available via the European Union, have seen more SMEs and Southern based contractors bid for one-off works. One Scotland frameworks supplier secured a large project in south-east England.

6.10 Real price effects

Real price effects (RPEs) describe categories of costs where our exposure to a cost category differs to the exposure of the typical UK household, as is measured under CPIH. For our replacement programme we see there are at least three distinct categories where RPEs apply: direct labour, contract labour and materials. Combined, these costs make up a significant proportion of our expenditure.

Although we have not applied further RPEs to our forecast for repex in GD2 on top of GD1, elements like street works and contract labour can have real impact on our annual replacement costs. We are expecting that any increases over and above the rate of inflation (CPIH) will be covered by an appropriate indexing mechanism to pick up RPEs over and above inflation. With that mechanism in place allowances will adjust appropriately year on year.

Much of the detail around RPEs can be found in section 3.5 of our Cost Efficiency appendix (005), where we discuss historical and future RPEs of the business including the repex programme of:

- contractual labour, which for Southern is mainly used for repex workloads;
- material costs;
- direct labour; and
- inflation rates (i.e. CPIH).

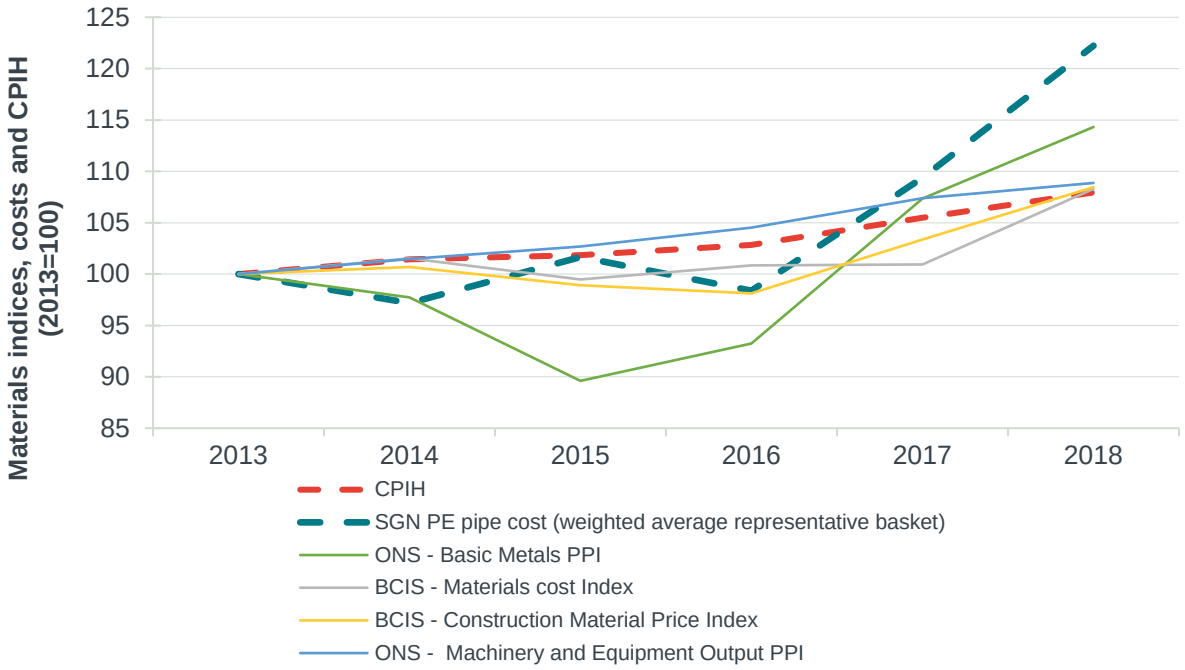
The outcomes of the RPE analysis summarised below in table 44, indicate that growth outstripped CPIH in all three areas.

Table 44: Summary of historical RPEs applicable to repex

	Percentage of repex Costs	Annual Growth in Costs	CPIH	RPEs
Contracted Labour	71%	5.06%	1.54%	3.52%
Materials	17%	4.10%		2.56%
Direct Labour	12%	2.57%		1.03%

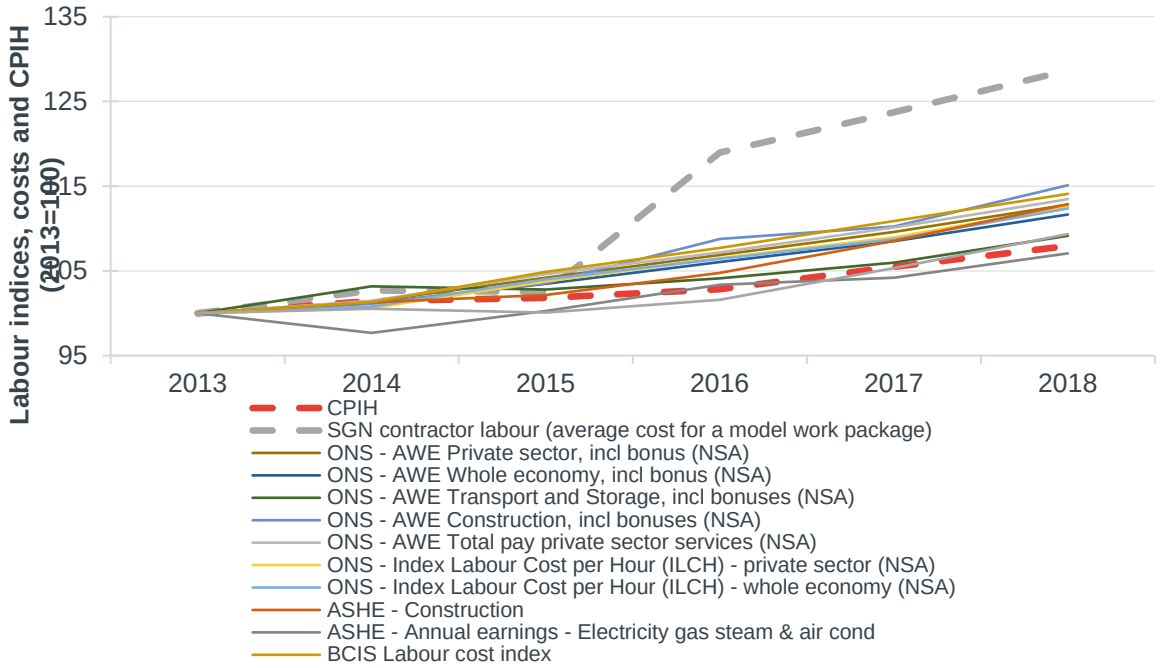
Materials make up 31% of our Totex and 17% of our repex. Our most substantial materials category is PE plastic pipe, which made up around 23% of our materials cost in 2018. We have found that materials costs increased by 4.1% (annualised) between 2013 to 2018, outstripping CPIH over the same period by 2.56%. This is a cost that will continue to rise as we progress into GD2. Figure 31 below sets out the range of indices we considered for RPE indexation for materials. More details are available in section 3.5 of our Cost Efficiency appendix (005).

Figure 31. Materials indices



As stated in our Cost Efficiency (005), contract labour makes up 43% of our Totex. A study of our repex contracts has found that of 115 rates reviewed, 72% outstripped CPIH. The cost pressures subsection in section 6.7 of this appendix shows the analysis Hargreaves Jones undertook of the variances and drivers in our contracting costs and related RPEs. It showed that contract labour costs outstripped CPIH by 3.52% between 2013 and 2018. Figure 32 below sets out the range of indices we considered for RPE indexation for contract labour. More details are available in section 3.5 of our Cost Efficiency appendix (005).

Figure 32. Contractor indices



There is a risk of using a broad index as there is not currently an index that exists in the UK or within the industry that reflects our very specific specialist skills and knowledge. Labour within the gas industry requires special qualifications and training rather than a general labour, the risk is a generic index does not cover our skill sets.

6.11 Financial summary

For the purposes of this Business Plan submission we have made our current forecast on the following assumptions:

- All prices are expressed in 2018/19 values.
- Cost pressures above RPI in our Southern Network only, between 2018/19 and the end of GD1 in 2020/21 have been included, reflecting the impact of recent tendering events where we have seen substantial increases in contractor rates for the work packages being let.
- Unit costs at the end of GD1 have been rolled forward into GD2 with a year on year productivity reduction of 0.5% per annum which we intend to review, seek additional evidence, and consult upon with our stakeholders.
- No cost pressures above CPI (RPEs) have been incorporated into our GD2 plan for either Scotland or Southern.
- The workload forecasts used throughout this paper, combined with the forecast average lay unit costs feed into the proposed replacement expenditure in our plan. If an alternative replacement strategy is chosen, then this will impact the repair workloads and hence repair operating expenditure.
- Cost lines are separated according to mandatory repex (HSE driven mains and services); asset management repex (non-HSE driven mains and devices); and risers and other repex mains.

On the basis of these assumptions we have set out both historical expenditure for GD1 and our forecast expenditure for the remainder of GD1 and continuing into GD2.

Mandatory repex mains and services (HSE driven) are expected to be broadly in line with the last five years of GD1 as we continue with the remaining workloads for the IMRRP at a linear level to complete the programme by 2032. We are also consulting with stakeholders on the merits of accelerating this programme to de-risk delivery by 2032.

We will continue to focus on the smaller diameter tier 1 iron mains, consistent with our approach in GD1, and reflecting both the remaining risk profile and the need to manage proposed investment in the light of future uncertainty.

As a consequence, a continuation of the HSE mandatory programme beyond GD2 will see a shift to the larger diameter tier 1 iron mains in line with the remaining population and diameter mix at that time.

Asset management repex comprise a number of activities including:

- Non-HSE driven mains and service workload will reduce by approximately 20% from GD1 levels, largely driven by a reduction in tier 2 and tier 3 iron workloads.
- Refurbishment and replacement of steel riser pipes will continue at broadly similar levels to the final years of GD1.
- A small number of specific asset integrity projects are included which are atypical and are shown separately in the BPDT.
- The riser workload and expenditure in GD2 will be broadly in line with our forecast for the final years of GD1.

Of the options that are considered, we have included our best current estimate for tier 1 stubs in the mandatory repex line as they will have to be completed, the associated costs and workloads may change as we receive more information and progress our analysis.

The accelerated tier 1 is not currently included in our mandatory repex line, as we are continuing to test this with our customers. We have had strong support to date, but we are looking to re-confirm these findings prior to determining its inclusion.

Our resilience projects for Kingsferry Bridge and IP Services are both included under other repex as all the information and assessments undertaken to date support the inclusion of these projects through the CBA process.

For hydrogen ready valves we are not yet comfortable that the CBA supports such a measure given the future uncertainty. For remotely operable valves, while there is strong customer support, a cost assessment has determined the cost is not within a range acceptable to the customer.

Table 45: GD2 forecast expenditure profile

SGN (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Mandatory HSE Mains & Services	190.3	187.1	179.9	193.5	193.5	183.9	190.1	187.5	205.5	206.7	205.1	204.4	205.2
Non HSE Mains & Services	30.4	31.9	36.2	38.2	52.1	65.0	66.5	66.3	40.0	39.3	38.2	37.3	36.7
Steel Risers	11.6	12.8	13.3	14.9	13.2	17.1	17.3	16.2	17.5	17.5	17.4	17.3	17.4
Other repex									7.3	0.9	0.9	0.9	0.9
Total	**232.3**	**231.8**	**229.4**	**246.5**	**258.8**	**266.0**	**273.9**	**270.0**	**270.2**	**264.5**	**261.6**	**260.0**	**260.3**
Scotland (£m)	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**25/26**
Mandatory HSE Mains & Services	48.7	47.3	52.7	50.2	47.8	48.0	46.0	45.9	53.5	53.8	53.3	53.2	53.6
Non HSE Mains & Services	6.8	7.3	7.9	9.8	12.6	19.6	17.6	17.2	9.2	9.0	8.8	8.7	8.6
Steel Risers	1.4	1.7	1.7	1.5	1.5	3.1	2.6	2.7	2.8	2.8	2.7	2.7	2.8
Other repex									0.7	0.7	0.7	0.7	0.7
Total	**56.8**	**56.2**	**62.4**	**61.4**	**61.9**	**70.8**	**66.3**	**65.8**	**66.2**	**66.3**	**65.6**	**65.3**	**65.7**
Southern (£m)	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26
Mandatory HSE Mains & Services	141.7	139.9	127.2	143.4	145.8	135.9	143.7	141.2	152.0	152.9	151.8	151.3	151.6
Non HSE Mains & Services	23.6	24.6	28.3	28.4	39.5	45.4	48.8	49.0	30.8	30.3	29.4	28.7	28.2
Steel Risers	10.2	11.1	11.5	13.4	11.7	14.0	15.1	14.0	14.7	14.7	14.6	14.6	14.6
Other repex									6.6	0.2	0.2	0.2	0.2
Total	**175.5**	**175.5**	**167.0**	**185.1**	**196.9**	**195.3**	**207.6**	**204.2**	**204.0**	**198.2**	**196.1**	**194.7**	**194.6**

Workload assessment

In GD2, we propose to decommission 1,403km of mains in Scotland and 3,604km in Southern and representing average annual workloads of 281km and 721km respectively, shown in the table below by asset type.

Table 46: Mains laid workloads – Scotland (km)

Scotland		2022	2023	2024	2025	2026	Total
T1 Length Laid	km	216.0	216.0	216.0	216.0	216.0	1080.0
T2 Length Laid	km	5.2	5.2	5.2	5.2	5.2	26.0
T3 Length Laid	km	1.7	1.7	1.7	1.7	1.7	8.6
Steel Length Laid	km	30.5	30.5	30.5	30.5	30.5	152.4
Other Length Laid	km	2.4	2.4	2.4	2.4	2.4	12.1
Total	**km**	**255.8**	**255.8**	**255.8**	**255.8**	**255.8**	**1279.2**

Figures exclude Diversions.

Table 47: Mains laid workloads – Southern (km)

Southern		2022	2023	2024	2025	2026	Total
T1 Length Laid	km	631.1	631.1	631.1	631.1	631.1	3,155.7
T2 Length Laid	km	10.3	10.3	10.3	10.3	10.3	51.4
T3 Length Laid	km	4.4	4.4	4.4	4.4	4.4	22.2
Steel Length Laid	km	41.6	41.6	41.6	41.6	41.6	208.1
Other Length Laid	km	3.0	3.0	3.0	3.0	3.0	15.0
Total	**km**	**690.5**	**690.5**	**690.5**	**690.5**	**690.5**	**3452.3**

Figures excludes Diversions.

Table 48: Mains decommissioning workloads – Scotland (km)

Scotland		2022	2023	2024	2025	2026	Total
T1 Length Decommissioned	km	229.1	229.1	229.1	229.1	229.1	1,145.3
T2 Length Decommissioned	km	5.2	5.2	5.2	5.2	5.2	26.2
T3 Length Decommissioned	km	1.7	1.7	1.7	1.7	1.7	8.6
Steel Length Decommissioned	km	38.6	38.6	38.6	38.6	38.6	201.5
Other Length Decommissioned	km	5.9	5.9	5.9	5.9	5.9	29.7
Total	**km**	**280.5**	**280.5**	**280.5**	**280.5**	**280.5**	**1,402.6**

Figures excludes Diversions.

Table 49: Mains decommissioning workloads – Southern (km)

Southern		2022	2023	2024	2025	2026	Total
T1 Length Decommissioned	km	643.8	643.8	643.8	643.8	643.8	3,219.0
T2 Length Decommissioned	km	10.3	10.3	10.3	10.3	10.3	51.4
T3 Length Decommissioned	km	4.4	4.4	4.4	4.4	4.4	22.2
Steel Length Decommissioned	km	543.5	543.5	543.5	543.5	543.5	267.4
Other Length Decommissioned	km	8.7	8.7	8.7	8.7	8.7	43.5
Total	**km**	**720.7**	**720.7**	**720.7**	**720.7**	**720.7**	**3,603.6**

Figures excludes Diversions.

Table 50: Service workloads Scotland

Scotland		2022	2023	2024	2025	2026	Total
Tier 1 Services	#	17,402	17,402	17,402	17,402	17,402	87,010
Tier 2 Services	#	305	305	305	305	305	1,526
Tier 3 Services	#	12	12	12	12	12	62
Steel Services	#	2,156	2,156	2,156	2,156	2,156	10,782
Other Services (awr)	#	66	66	66	66	66	330
Other Services (nawr)	#	1,681	1,616	1,554	1,496	1,440	7,786
Total	**No**	**21,622**	**21,558**	**21,496**	**21,438**	**21,382**	**107,496**

awr/nawr – associated with mains replacement/not associated with mains replacement.

Table 51: Service workloads Southern

Southern		2022	2023	2024	2025	2026	Total
Tier 1 Services	#	57,215	57,215	57,215	57,215	57,215	286,075
Tier 2 Services	#	1,046	1,046	1,046	1,046	1,046	5,232
Tier 3 Services	#	5	5	5	5	5	25
Steel Services	#	1,344	1,344	1,344	1,344	1,344	6,720
Other Services (awr)	#	178	178	178	178	178	890
Other Services (nawr)	#	9,401	9,031	8,680	8,347	8,030	43,489
Total	**No**	**69,189**	**68,820**	**68,469**	**68,136**	**67,819**	**342,432**

awr/nawr – associated with mains replacement/not associated with mains replacement.

The unit costs for delivering the programme are defined through an extensive procurement programme. Prior to GD1, our contracting strategy was via an Engineering Procurement and Construction Contract (EPC) with a sole supplier in Southern to cover 95% of mains replacement activity; Scotland also used an EPC but with a limited geographical footprint supported by smaller contractors where necessary.

6.12 Assurance

Our Business Plan, including appendices, has been subject to a rigorous assurance process which is detailed in Chapter 3 of the Plan and the Board Assurance Statement.

Our Network Director was appointed as the Sponsor for the Replacement (repex) appendix and the associated CBAs, EJPs and BPDTs; which have been through the following levels of review and assurance:

First line

This was undertaken at project level by the team producing the document, as a regular self-check or peer review.

Second line

This was undertaken independently within the organisation to review and feedback on product development, including workshops on capex, CBAs and EJPs. Internal audit reviewed the third line assurance work conducted by Ove Arup and Partners against scope.

Both Senior Manager and Director sign-off was obtained and our GD2 Executive Committee: (1) considered the appropriateness of assurance activity for the appendix; and (2) provided assurance to SGNs Board that the Business Plan meets Ofgem's assurance requirements.

Third line

This was undertaken by external advisors and groups providing critical challenge during the development of products within the Business Plan. In addition to the feedback and challenge provided by the Customer Engagement Group (CEG) and Customer Challenge Group (CCG) this appendix was developed after consultation with and advice from:

Advisor/Group	Contribution
Ove Arup and Partners	Consultancy support to enable development of an evidence based high quality Business Plan draft by acting as an expert challenge group through independent peer reviews against Ofgem Business Plan Guidance.
Advanced Engineering Solutions	Consultancy on proactive steel.

Fourth line

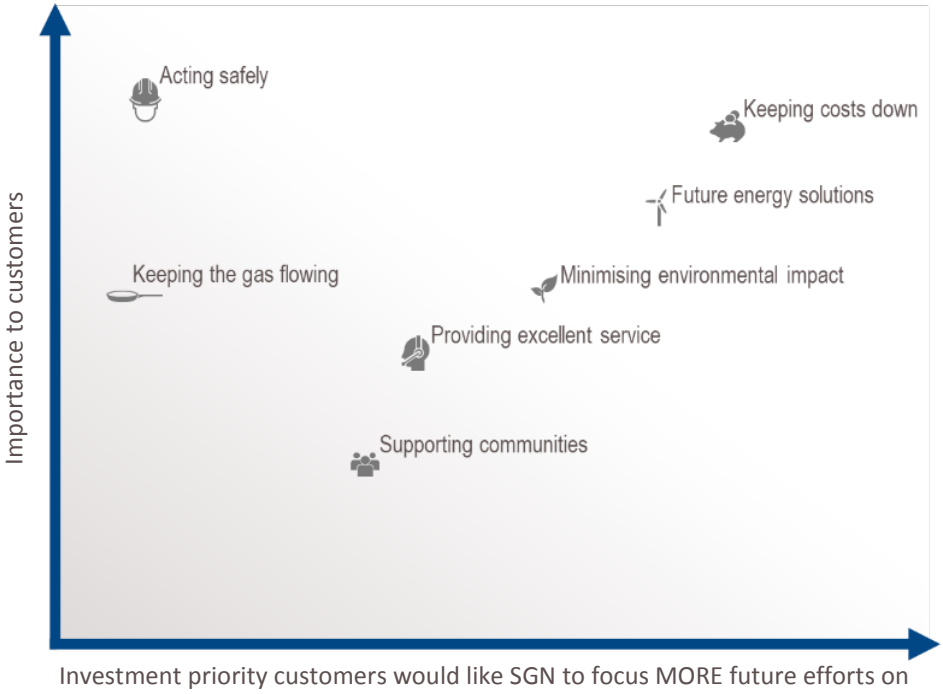
This was undertaken by independent and impartial external providers, who provided a detailed and comprehensive report to both the Executive Committee and Board of Directors:

Advisor/Group	Contribution
Ove Arup and Partners ('Clean' Team)	Review of appendix against Ofgem's assurance requirements.
PwC	BPDT review: Streetworks, repex Mains Tier-1, repex Mains Tier-2B and 3, repex Multiple Occupancy Buildings (MOB), repex Cost Breakdown, Shrinkage, Reliability and Network Assets.

7 Stakeholder annex

As set out in section 4 above, we have undertaken a comprehensive programme of stakeholder and customer engagement throughout the development of our Business Plan. This is described in detail in the Enhanced Engagement appendix (022) and chapter 4 of our Business Plan.

Our programme of customer research shows that customers view keeping costs down as their top priority. The results also demonstrate that while acting safely and keeping the gas flowing are of high importance, customers view our current level of performance as already very good and would therefore expect us to maintain our current levels of performance.

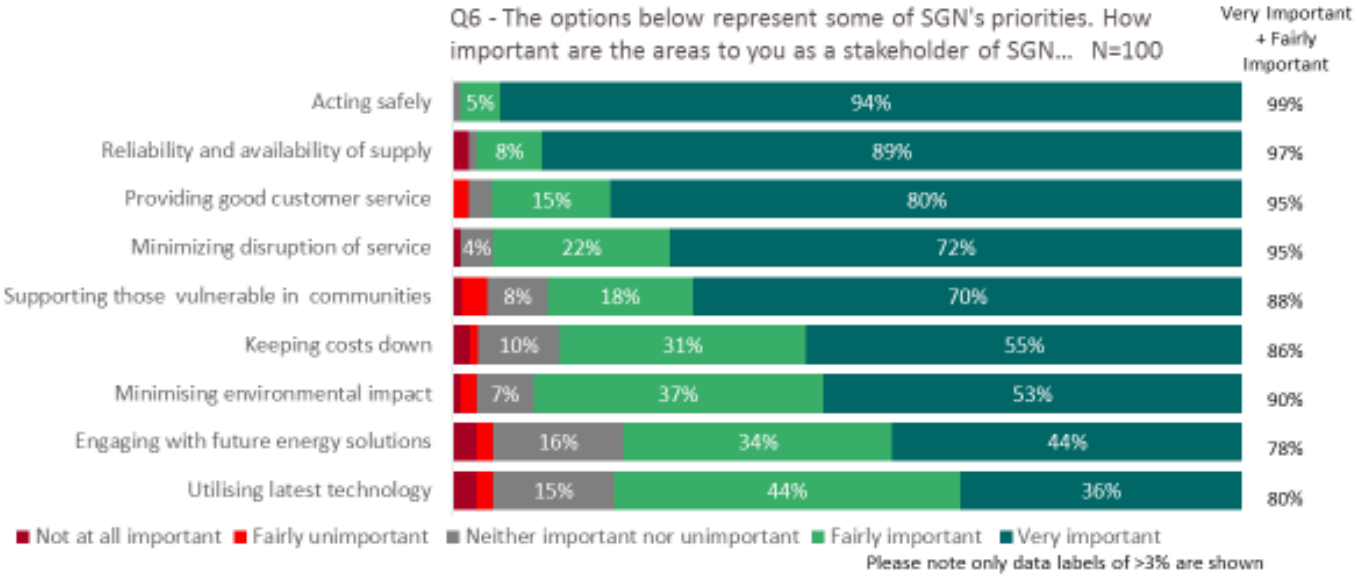


The prioritisation of safety and maintaining reliable gas supplies has also been identified by our stakeholders. Our first wave of stakeholder satisfaction surveys demonstrated that 97% of stakeholders responding to the survey rated these two areas as fairly or very important.

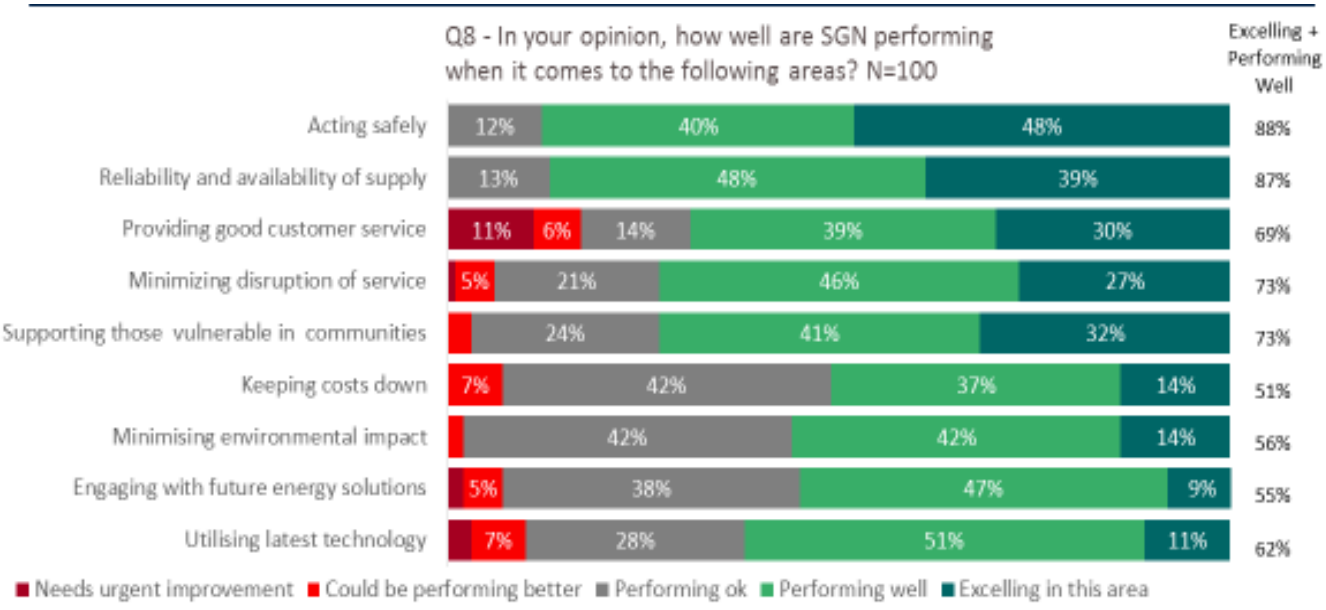
In a recent stakeholder study: safety, reliable gas supply and good customer service were ranked as the most important to stakeholders

Key Insight: All priorities are important to stakeholders.

Implications for GD2: 'Supporting those vulnerable in communities' and 'providing good customer service' are higher priorities for stakeholders than for customers.



More than 87% of stakeholders surveyed felt we were performing well or excelling in relation to acting safely and reliability and availability of supply. None felt we could be performing better or needed to urgently improve.



At its core, our GD2 plan is focussed on keeping the gas flowing safely by continuing to provide a reliable network. It was evidenced in a poll at a Moving Forward Together workshops in March 2017 that our stakeholders agree that this is an extremely important priority. In addition, almost half of the stakeholders attending these events felt that investing in innovation was of the highest importance when seeking to minimise disruption.

Figure 33. Five priority areas of our business

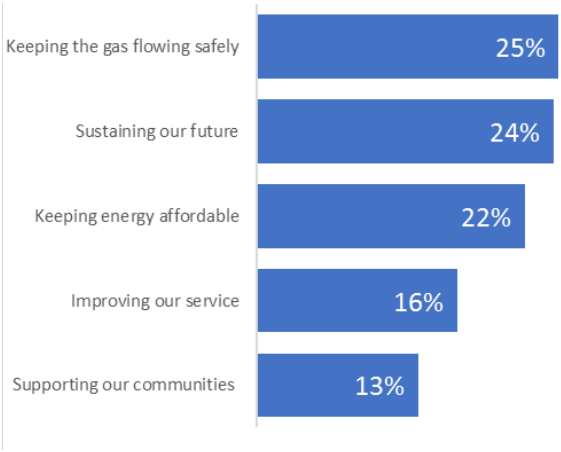
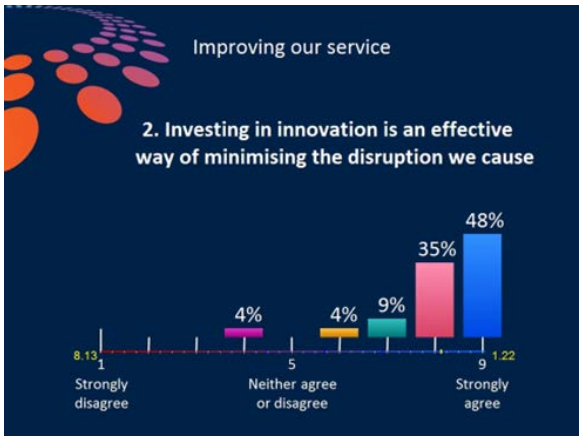
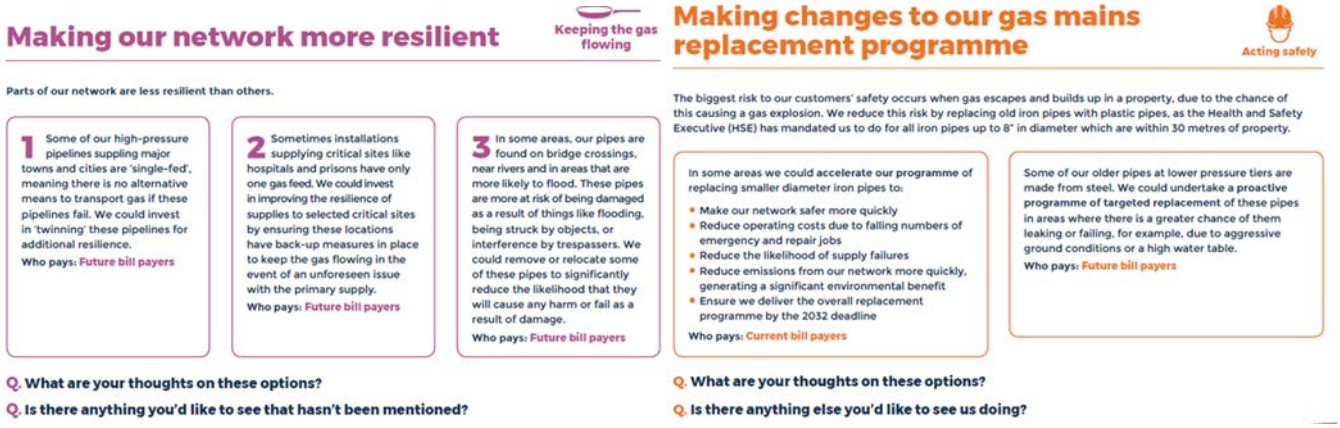


Figure 34. Minimising disruption



This discussion was progressed further in our Moving Forward Together workshops in November 2018. We discussed with stakeholders the level of resilience on our network and making changes to our gas mains replacement programme.

Figure 35. Safety and reliability



Stakeholders generally supported changes that brought safety and reliability benefits but said they would expect SGN as the engineering experts to make a reasonable decision as to whether this was necessary based on the potential risks involved, the consequences of failure and the associated costs of any interventions.

Our first wave of customer willingness to pay research revealed that 88% of customers would be willing to pay an extra 9p per annum to speed up the replacement of old pipes.

In our quantitative acceptability testing, customers were asked a question in relation to improving the reliability and safety of our network. Customers exhibited high levels of acceptability for our proposals to enhance the

reliability and safety of gas pipes, for example by removing steel tails from gas services, removing redundant pipework and doing more inspections of medium-rise blocks of flats. These additional elements attracted the highest acceptability levels of all the options tested, scoring 85% in total for southern customers and 89% in total for customers in Scotland.

In the same body of research, customers were asked a question in relation to improving reliability in areas that suffer more frequent interruptions by replacing steel pipes with PE. Again, this proposed additional element of our plan attracted high levels of acceptability. In general, customers in Scotland gave high levels of acceptability for this option (85% for domestic customers, 84% for Scottish SMEs). Southern customers were similarly high, giving 80% acceptability in total across both domestic customers and SME business customers.

7.1 Risers

There was strong agreement from stakeholders at our November 2018 Moving Forward Together workshops that the safety of risers must be maintained, even if there is some uncertainty about the longer-term future of using gas in multi-occupancy high-rise buildings. Stakeholders recognised the importance of gathering riser data for medium rise buildings, continuing our journey to gather and enhance our data and using it as part of our risk-based approach to these assets. Some stakeholders also raised the concern that removing gas risers from multi-occupancy buildings would detrimentally affect customers who couldn't afford other more expensive heating solutions. It was felt that until there was clarity on the future use of risers on medium and high-rise buildings, it was desirable to make them as safe as possible. Further stakeholder insight relating to multi-occupancy buildings is contained in our Asset Maintenance appendix (016).

7.2 Impact of repex works on stakeholders

We work closely with stakeholders in advance of the work we carry out (as well as during the work) to minimise any disruption and negative impact. It is important to us that we have that engagement at an early stage to get stakeholder support and that they understand the work we are carrying out as well as why we need to carry out the work.

We engage with local authorities and, in the case of riser replacement jobs, other building owners during the planning and design phases to ensure they have no concerns and agree to the work we carry out. This early engagement is important in cases where there are other works in the same vicinity or building, allowing us to make arrangements to work co-operatively to keep customer disruption to a minimum.

Residents are also kept informed of the work that we will be carrying out at their homes or to their supplies. This is usually in the form of regular letters prior to and during works, as well as residents' meetings and often posters and leaflets displayed in the area.

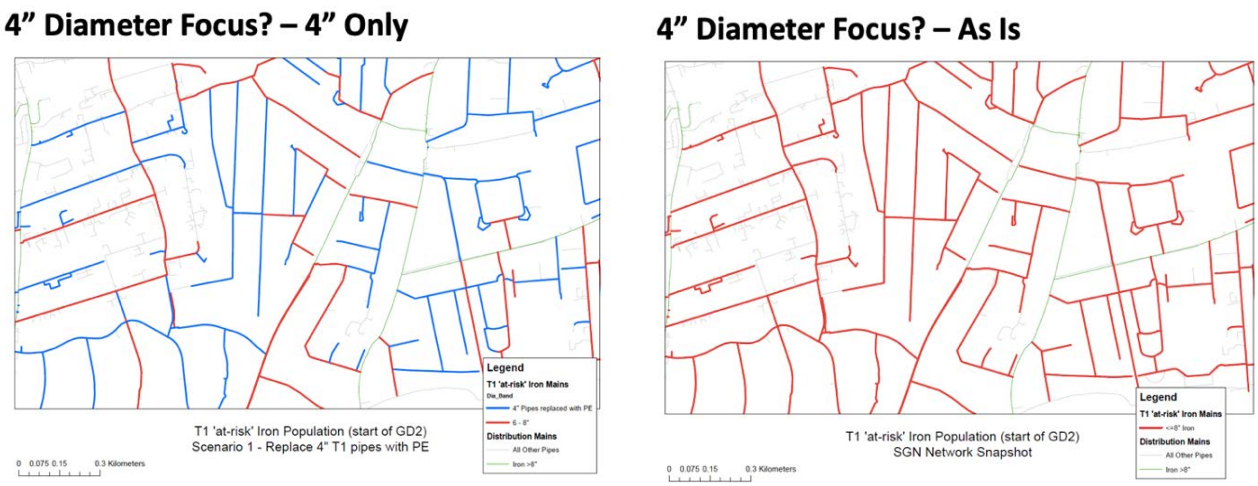
We often receive positive feedback from our stakeholders, such as the following examples:

> *"SGN consistently provide the support we need in terms of regular and open communication and guidance. This allows us to work together to deliver great customer service and maximise value for the GB gas consumer when upgrading the riser network." Wayne Miles, Director – Actionshake Ltd*
>
> *"Southwark and SGN have developed a strong working relationship with regular updates and open dialogue on the programme of riser upgrade work on our buildings. This gives us the confidence we need to support these works and ensure the work is delivered efficiently and with minimal disruption." Tony Hunter, Head of Engineering – Southwark Council*
>
> *"The workforce I spoke to were all pleasantly informative and helpful. Teamwork in play showed!" Brighton resident*

At our January/February Moving Forward Together workshops we presented two case studies to stakeholders.

The first case study related to whether we could a) initially focus on the smaller diameter pipes that fail most and cost less to replace, returning to replace the larger pipes later on (but still before 2032); or b) replace all tier 1 pipes in an area as one project, meaning we would not need to return again during the IMRR

Figure 36. 4" diameter focus?



Stakeholders were asked to discuss and devise an agreed set of criteria they would expect us to be considering when making these types of decisions about mains replacement. They were then asked to consider which criteria they felt were most and least important, giving an aggregated picture of the relative weighting stakeholders placed on each of the criteria.

The results showed a clear focus on reducing disruption, followed by reducing costs and then future proofing the network. In terms of least important, co-ordination with councils, short term cost reduction and delivery were considered least.

Figure 37. London MFT – January 2019

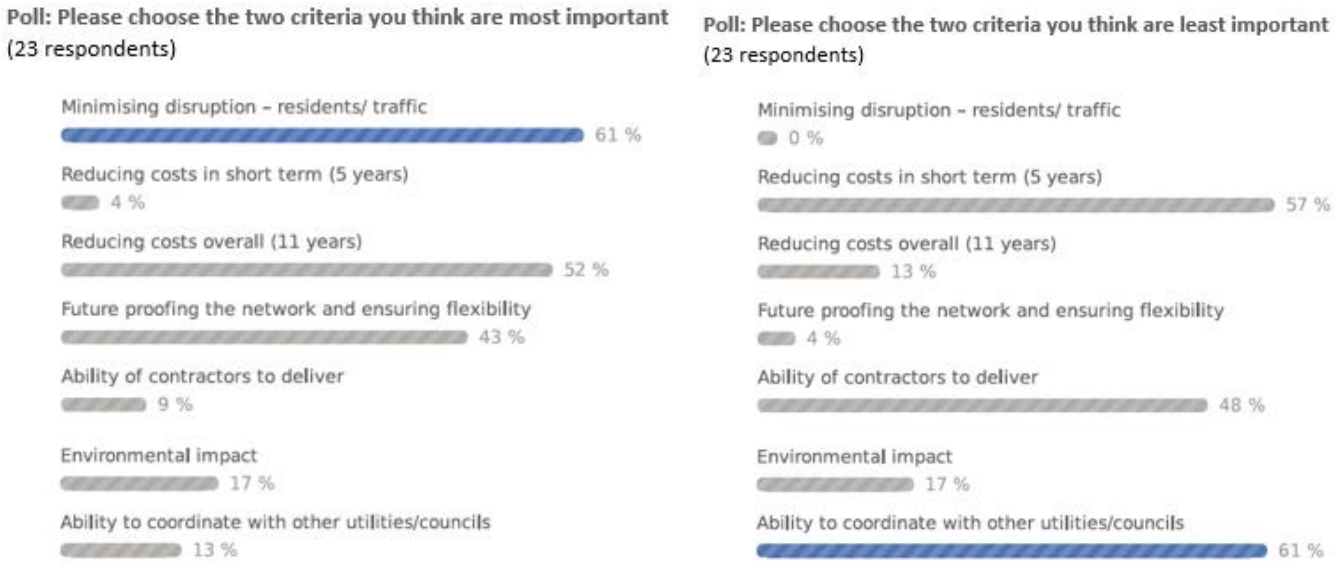
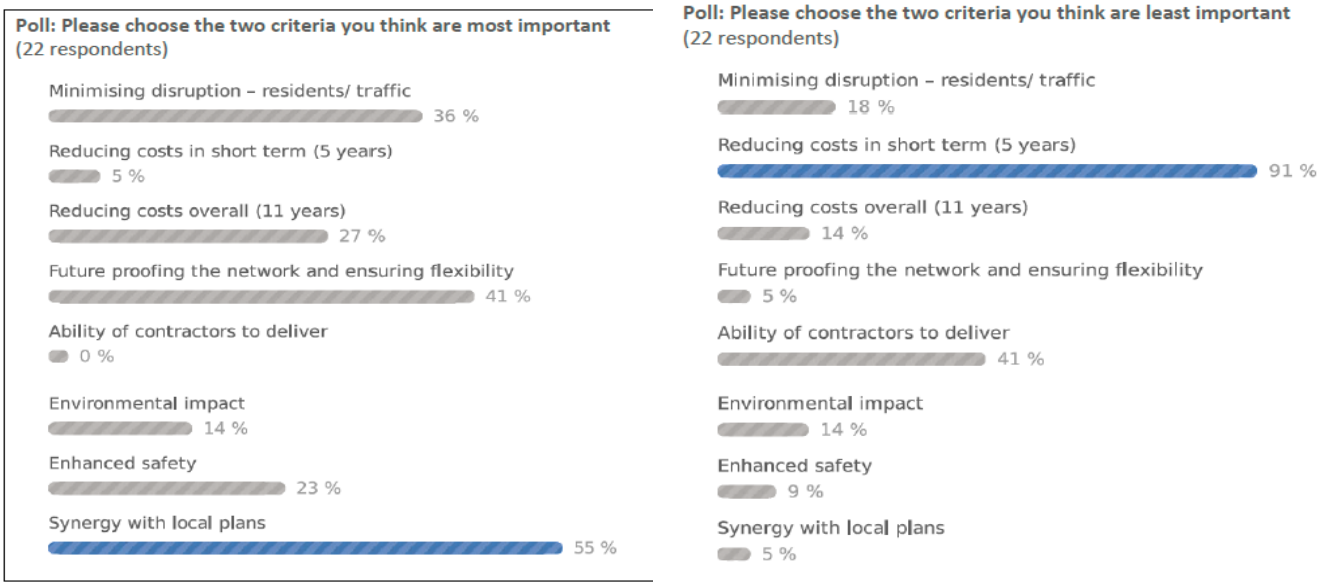


Figure 38. Glasgow MFT – February 2019



Stakeholders were then presented with the second case study, which focused on the timing of the programme. Two possible options were described: flatline to the end, or do more each year, allowing for a tail-off, as discussed in section 6.2 above. Participants were then asked to what extent the criteria and their weighting used for decision making would change when considering this case study.

The focus of these conversations was not specifically on which option or case study each stakeholder would opt for but was instead aimed at agreeing a set of decision-making criteria. Having worked with stakeholders to devise this set of criteria, we are now able to apply them when making investment decisions on our network.

8 Glossary

All acronyms and associated descriptions can be found within the Glossary appendix.

9 Project annex

Annex redacted