Engineering Justification Paper: EJP08

Mains Tier 1 (IMRRP) and Associated Services

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1 Summary Table

Name of Project	Mains Tier 1 (IMRRP) and Associated Services		
Programme Reference	IMRRP and Associated Services		
Primary Investment Driver	Asset Health		
Project Initiation Year	2002		
Project Close Out Year	2032		
Total Installed Cost Estimate (£m)	[Cost Information Redacted]		
Cost Estimate Accuracy (%)	+/-5%		
Project Spend to date (£m)	0		
Current Project Stage Gate	Ongoing 30-year project		
Reporting Table Ref	CV6.01, CV6.05 CV6.08, CV6.11		
Outputs included in RIIO-3 Business Plan	Yes		
Spend apportionment (£m)	RIIO-2	RIIO-3	RIIO-4
	[Cost Information Redacted]	[Cost Information Redacted]	[Cost Information Redacted]

Table 1: Summary of Investment Proposal

Prices are pre-efficiency and are in 2023/24 price base.

This investment case does not satisfy the criteria for late competition or early competition and pursuing these activities would not be in the interests of the customer. We recognise the benefits that competition can bring to customers through efficiency and innovation. We continue to challenge ourselves as a business to ensure that we are harnessing competitive forces where they can provide these benefits. For specific detail on how we have assessed competition, please see Section 6 of the Workforce and Supply Chain Strategy (Appendix 17).

2 Executive Summary

There is a link between the work described under this EJP and the programme of work envisaged under EJP09-Cost Beneficial Mains Replacement. EJP09-Cost Beneficial Mains Replacement provides estimated costs for and justifies our plan to target additional repex investments to reduce leakage. This additional repex will improve the safety of our network and benefit the environment. An overall programme of repex work that includes the additional work envisaged in EJP09-Cost Beneficial Mains Replacement will allow us to optimise planned work, thereby increasing the efficiency of the mandatory repex programme. This is reflected in our EJP08-CBA-Mains IMRRP.

Our customers want a safe and reliable service. We also have obligations under pipeline safety regulations (1996)[1] which mean we must act where pipes are in an unsuitable condition to transport gas. Under the Health & Safety Executives (HSE's) Iron Mains Risk Reduction Programme (IMRRP) all tier 1 iron pipes within 30m of a building must be replaced by the end of December 2032.

This paper covers investment in this mandatory Tier 1 IMRRP including asbestos cement mains and associated below 2" Steel to ensure we deliver for our customers and deliver against our obligations.

The replacement of all Tier 1 (up to and including 8" diameter) iron pipes[2] where they are within 30m of a building is mandated through the HSE's enforcement policy.

Whilst replacing the iron mains within 30m of a building we replace associated small diameter steel mains and steel service pipes, reducing revisits to the same location and is cost effective.

IMRRP is a mandatory programme of work and therefore we have limited choice on the scale of the programme and delivery profiles. In this EJP we present three modelled scenarios, for these we have taken a whole network approach to developing the plan, coordinating programmes of work across IMRRP, safety and cost beneficial mains replacement using a modelled approach that considers delivering the mandated work alongside other works, which allows us maximise costs efficiency through longer schemes and mitigation of the need to manage stubs.

We want to significantly play our part in decarbonising the gas distribution system. We have an ambition to be net zero by 2050 and aim to achieve a material reduction in our Scope 1[3] and Scope 2 emissions by 2040/41. IMRRP replacement is a critical part of this strategy. We have used our learnings from the new technologies deployed in RIIO-2 and the data collected to calculate emissions at a granular asset level, allowing us to more accurately quantify the benefit of this investment to customers and society.

In preparing the RIIO-3 plan we have analysed works delivered in RIIO-2 vs the remaining assets to be delivered in RIIO-3 to develop a robust relationship between complexity and cost. We have developed our Asset Investment Management (AIM) capability, building on its use to build our RIIO-2 plan by including [Commercially Sensitive Information Redacted].

Our proposed RIIO-3 programme of work for IMRRP is comprised of [sensitive data] of mains renewal and the replacement or transfer of associated services. Using the detailed costing model developed for RIIO-3, this will see us invest [cost data] in our networks. See

[Commercially Sensitive Information Redacted]

[1] Pipeline Safety Regulations 1996
[2] We treat the small length of tier 1 asbestos mains in the North West network as we would tier 1 iron mains.
[3] https://www.deloitte.com/uk/en/issues/climate/zero-in-on-scope-1-2-and-3-emissions.html

Table 2 for details of our proposed mains replacement volumes;

[Commercially Sensitive Information Redacted]

Table 3 for details of our proposed service intervention volumes, and

[Commercially Sensitive Information Redacted]

Table 4 for details of our proposed costs.

Our investments in RIIO-3 will deliver the following benefits:

- Reduce incident risk as calculated in the Mains Replacement Prioritisation System (MRPS)
- Reduce mains failure, producing an opex saving for customers
- Reduce the probability of an interruption to supply
- Reduce mains leakage, delivering environmental benefits

Further details on our environmental ambitions can be found in EJP09-Cost Beneficial Mains Replacement and our Environmental Action Plan.

[Commercially Sensitive Information Redacted]

Table 2: Proposed Volumes (Tier 1 iron, ≤2" steel and asbestos only, associated services excluded)

[Commercially Sensitive Information Redacted]

Table 3: Proposed Volumes - Number of Service Interventions

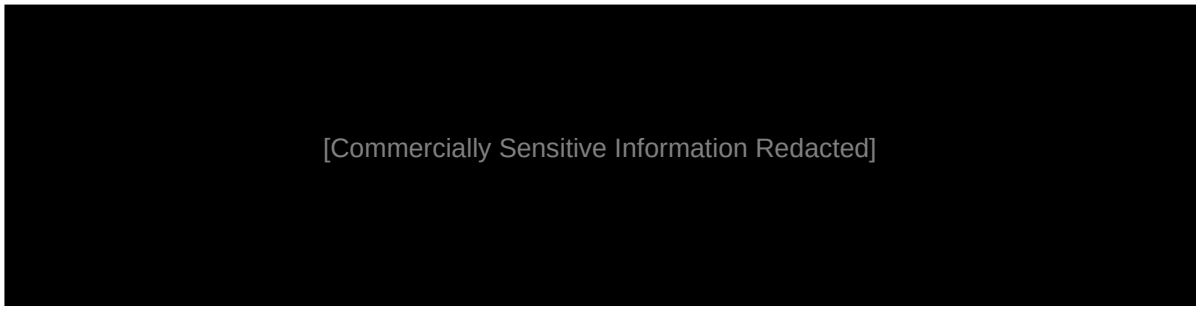

Table 4: Proposed Costs (Tier 1 iron, below 2" steel, asbestos and associated services)

3 Introduction

This paper covers the investment for Cadent's IMRRP, asbestos mains, services connected to IMRRP mains and associated below 2" steel. The IMRRP investment is mandated by the HSE[4] and addresses the failure of 'at risk' iron gas mains; and any services associated with this pipework.

The IMRRP is a mandatory programme of work to ensure the safety of our customers. The replacement of aged iron pipes delivers wide customer and societal benefits including reduce risk to property and life, reduced repairs (cost and disruption), reduced leakage and reduced interruptions to supply.

A key part of our strategy for RIIO-3 relates to our environmental impact, a large part of which is a result of leakage and carbon emissions, with our ambition to be net zero by 2050 and aim to achieve a material reduction in our Scope 1 and Scope 2 emissions by 2040/41.

In RIIO-2 we have extensively piloted emission detection technologies which have enabled us to create robust models to predict emissions from our network. From this data we have created a Hybrid Leakage Model (HLM) used in the development of our RIIO-3 plans. The use of the HLM in developing our IMRRP programme means that we can better account for emissions from our network. We have used the HLM alongside the industry Standard Leakage Model (SLM) when comparing CBA benefit of our investment options.

Where assets are aligned to the IMRRP programme we have included them within our programme of works to derive delivery efficiencies and to reduce customer disruption. Section 4 summarises all assets covered in this paper, in summary:

- Tier 1 iron mains: Tier 1 iron pipes where they are within 30m of a building

[4] http://www.hse.gov.uk/gas/supply/mainsreplacement/index.htm.

- Asbestos mains: Asbestos cement pipes are treated in the same way as we treat iron mains as their failure modes and risk are analogous
- Associated services: Steel and mixed material (part PE, part steel) domestic size service pipes shall be replaced when the main that supplies them is replaced. Where the service mains are already PE they will be transferred if fit for purpose
- Associated below 2" steel mains: Steel mains below/equal 2" that are associated with Tier 1 iron pipes (that is attached to a Tier 1 pipe being replaced) shall be replaced

The quantification of risks and benefits in this engineering justification paper has been developed using our standardised Asset Health Investment Decision making process, which utilises investment decision making models that consider the asset base, its age, condition, and current performance, to forecast the future failures and associated risks and consequences to support decision making. This work is mandatory and whilst some optioneering has been performed we have limited choice about the required intervention, therefore modelling outputs are illustrative rather than for option development.

In RIIO-2 we proposed to lower risk and comply with the IMRRP by delivering a flat profile of work over the five-year period. The tables below show actual costs and volumes, with projected values for the remaining two years of RIIO-2.

Asset	Network	2022	2023	2024	**2025**	**2026**	**Total**
Tier 1 Iron (km)	EE	527	586	601	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NL	298	289	288	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NW	424	412	382	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	WM	285	308	301	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	Total	**1535**	**1596**	**1571**	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Figure 1: RIIO-2 IMRRP Actuals and Projected Volumes, Tier 1 Iron

Asset	**Network**	**2022**	**2023**	**2024**	**2025**	**2026**	**Total**
Steel ≤2" (km)	EE	13	15	14	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NL	8	13	11	[Commercial	[Commercial	[Commercial

Asset	Network	2022	2023	2024	2025	2026	Total
					y Sensitive Information Redacted]	y Sensitive Information Redacted]	y Sensitive Information Redacted]
	NW	21	25	26	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]
	WM	11	9	9	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]
	Total	**54**	**62**	**59**	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]	[Commerciall y Sensitive Information Redacted]

Figure 2: RIIO-2 IMRRP Actuals and Projected Volumes, ≤2" Steel

Asset	Network	2022	2023	2024	2025	2026	Total
Services (Number)	EE	40,019	54,928	52,137	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NL	31,070	31,992	31,795	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NW	42,439	39,933	33,526	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	WM	26,606	29,164	26,402	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	Total	**140,134**	**156,017**	**143,860**	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Figure 3: RIIO-2 IMRRP Actuals and Projected Volumes, Services

Asset	Network	2022	2023	2024	2025	2026	Total
Tier 1 Iron (£m)	EE	99.86	120.09	117.84	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Asset	Network	2022	2023	2024	2025	2026	Total
	NL	79.46	84.09	93.51	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NW	85.98	77.88	74.79	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	WM	54.52	53.49	55.27	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	Total	**319.82**	**335.55**	**341.41**	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Figure 4: RIIO-2 IMRRP Actuals and Projected Costs in 23/24 Price Base, Tier 1 Iron

Asset	Network	2022	2023	2024	2025	2026	Total
Steel ≤2" (£m)	EE	2.19	2.24	2.05	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NL	1.88	2.98	2.86	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NW	3.1	2.96	3.41	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	WM	1.55	1.08	1.28	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	Total	**8.72**	**9.26**	**9.6**	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Figure 5: RIIO-2 IMRRP Actuals and Projected Costs in 23/24 Price Base, ≤2" Steel

Asset	Network	2022	2023	2024	2025	2026	Total
Services (£m)	EE	32.63	38.3	36.64	[Commercially Sensitive	[Commercially Sensitive	[Commercially Sensitive

Asset	Network	2022	2023	2024	2025	2026	Total
					Information Redacted]	Information Redacted]	Information Redacted]
	NL	28.49	27.56	30.26	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	NW	22.12	20.33	18.54	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	WM	21.02	20.58	19.98	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]
	Total	**104.26**	**106.77**	**105.42**	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]	[Commercially Sensitive Information Redacted]

Figure 6: RIIO-2 IMRRP Actuals and Projected Costs in 23/24 Price Base, Services

4 Equipment Summary

4.1 Distribution Mains

Our distribution mains form a network 127,155km in length, connecting our Local Transmission System (LTS) to homes and businesses. They run underneath every street which has a gas supply.

The makeup of the networks is the result of over a century of investment, policy and regulation in the transportation of gas. Over time, there have been various approved materials to carry gas, sanctioned replacement techniques and maintenance regimes to manage the assets.

A summary of the asset stock within scope of the IMRRP in each region, by material covered by this EJP is shown in Table 5 below.

Material	Type	EE	NL	NW	WM	Total
Iron (km)	Tier 1 ≤30m	4,479	2,708	3,086	2,398	**12,671**
Steel (km)	≤2" ≤30m	402	200	638	258	**1,498**
Asbestos Cement (km)	Tier 1	0	0	44	0	**44**
	Total	**4,881**	**2908**	**3768**	**2656**	**14,213**

Table 5: Asset Base as per 2023/24 RRP

As per Table 5 the North West network has a relatively large volume of Asbestos Cement mains, we treat these as we would iron and therefore must be removed as part of the IMRRP.

The total population of below 2" steel across the four Cadent networks is over 2,100km however only the below 2" steel connected to IMRRP pipes will require replacement with the IMRRP programme, therefore we have provided the length of below 2" steel pipes within 30m as an indicator of the asset stock that will need replacing alongside the IMRRP programme.

Within the North London network, there is approximately 3.7km of Tier 1 iron that is within subways. Due to the unique nature of this work, we are proposing to carry out a feasibility study to determine the best approach and the expected costs of carrying out the work before the end of the programme. For more details on this study please see the Uncertainty Mechanism section of the business plan document (UM.A7).

4.2 Associated Services

We have over 11 million service pipes supplying customers in domestic, industrial, commercial, and multiple occupancy buildings (MOBs) direct from the network. Across our networks approximately 10% of the total number of services are associated with tier 1 mains in scope of the IMRRP programme.

Table 6 below shows the breakdown of all services and the subset of those services which are associated with the IMRRP programme, by network.

'000s	EE	NL	NW	WM	Total
Services (k)	4,948	2,288	2,703	1,975	11,913
Services associated with IMRRP (k)	392	326	257	218	1,193
% Tier 1 Services	7.9%	14.2%	9.5%	11.0%	10.0%

Table 6: Services Asset Base by Customer Type as per 2023/24 RRP

5 Problem/Opportunity Statement

For RIIO-3, the HSE has confirmed that the risk posed by all tier 1 pipes still needs to be removed by the end of 2032 or sooner, as these pipes have historically presented the most significant risk of a Gas in Building (GIB) events, the precursor to an explosion.

We have a duty to maintain a safe network and comply with the Pipeline Safety Regulations (1996) and the Gas Safety (management) Regulations 1996. [Commercially Sensitive Information Redacted]

As part of routine activity, we replace steel services and steel mains which are below 2" in diameter if connected to a main we are replacing. We treat the limited volume of asbestos mains in the same way we treat iron mains as the failure mode and risk they pose is analogous. This approach agreed with the HSE and is required to comply with Pipeline Safety Regulation 13a and cost-effectively removes safety risks. The benefit of this investment is an improvement in safety for customers and the avoidance of having to revisit the same location to replace these assets later.

5.1 What happens if we do nothing

The assets will deteriorate and will pose the following service risks:

- Safety: Iron mains pose a risk of failure and fracture which in turn would lead to release of gas from the mains, and potential for gas build up within buildings, leading to possible explosions. Failure to replace these pipes will see a rise in escapes and explosions
- Environmental: Any release of gas from our mains will result in additional carbon emissions
- Regulatory compliance: We have legal obligations to comply with the PSR 1996 and GSMR 1996, and a mandate from the HSE to complete the works by 2032
- Security of supply. Failures of distribution mains could result in customer interruptions
- Financial: Every escape from our network carries a cost of attending and repairing the pipe, as well as restoration of any supplies turned off, or lost during the leak
- Other: Continued failure of the same main will cause high levels of customer disturbance, and in turn dissatisfaction

5.2 Key outcomes and understanding success

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5.3 Narrative real-life example of problem

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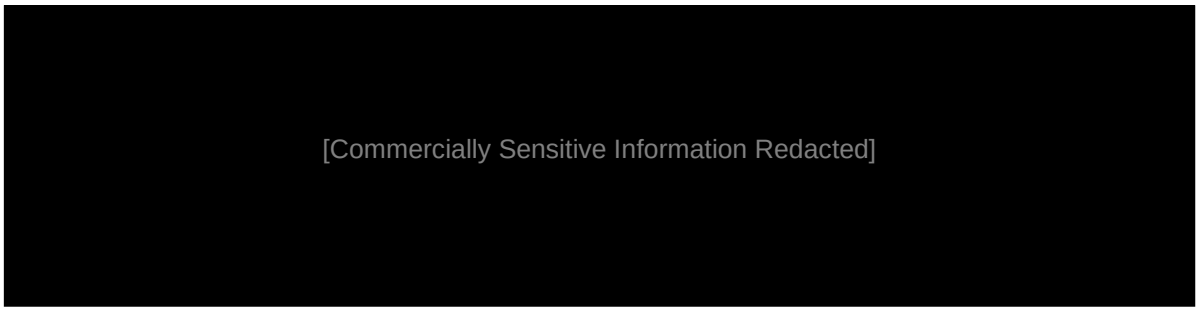

Figure 7: [Commercially Sensitive Information Redacted]

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5.4 Alignment with overall RIIO-3 investment strategy

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5.5 Project Boundaries

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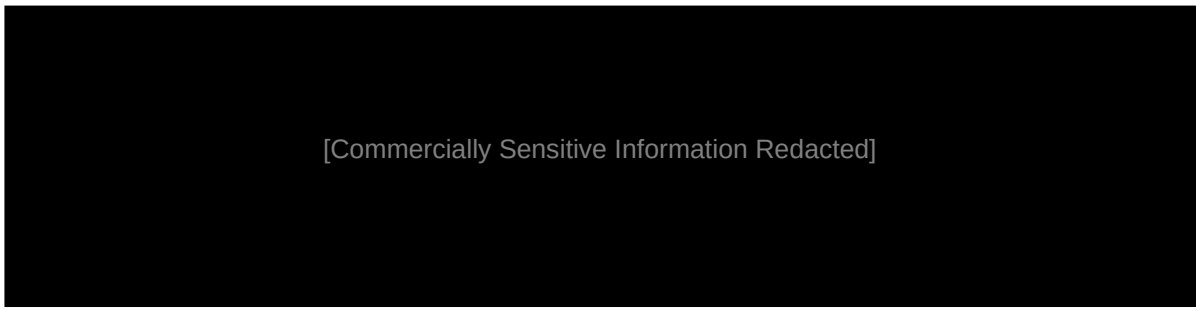

Figure 8: Diagram of a Typical Stub

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6 Probability of Failure

[Commercially Sensitive Information Redacted]

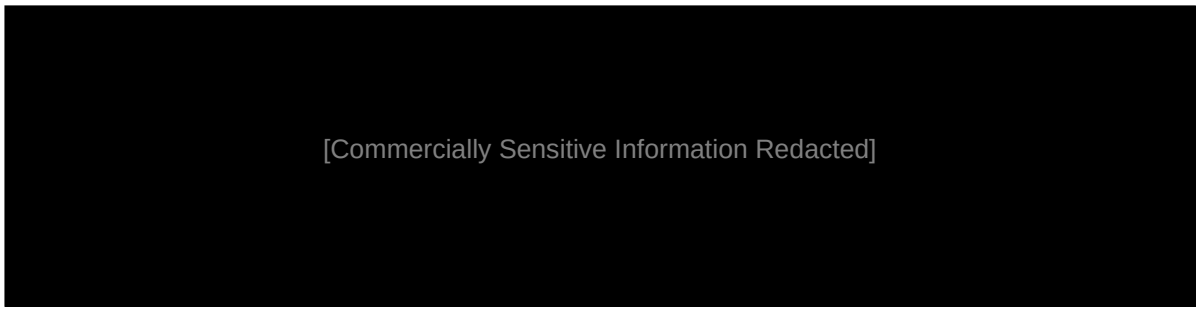

Table 7: Deterioration Rates Assumes in the RIIO-3 Mains Planning

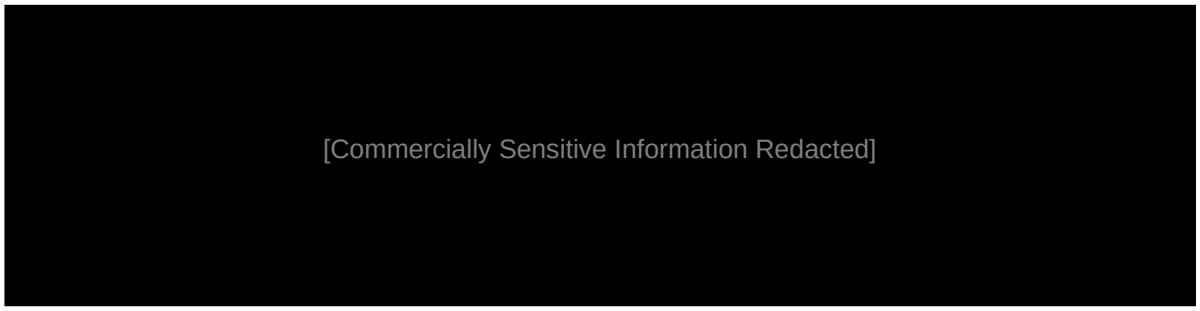

Figure 9: [Commercially Sensitive Information Redacted]

6.1 Probability of Failure Data Assurance

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7 Consequence of Failure

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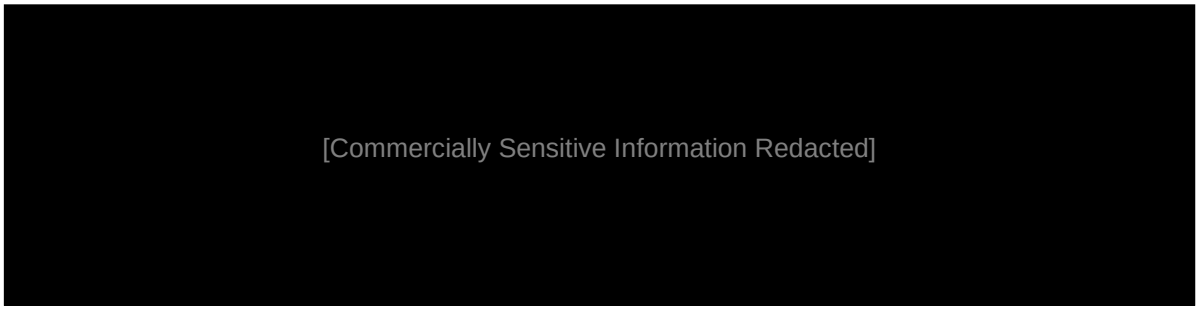

Figure 10: [Commercially Sensitive Information Redacted]

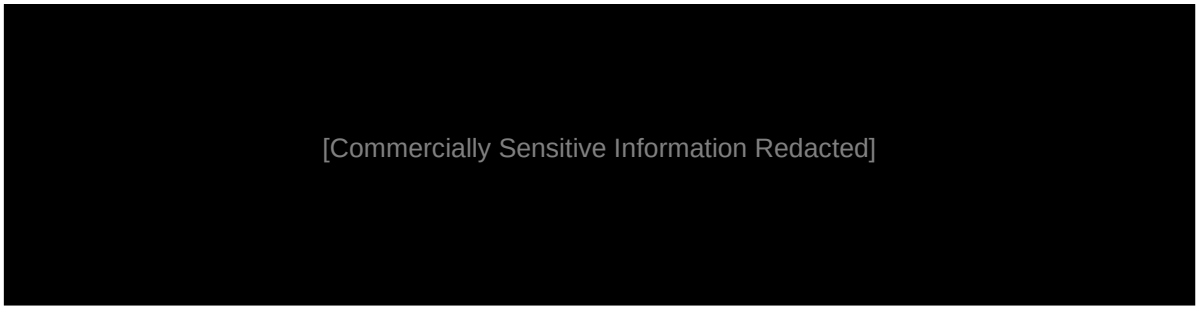

Table 8: MRPS Calculated Incident Probability by Network (RRP 23/24)

[Commercially Sensitive Information Redacted]

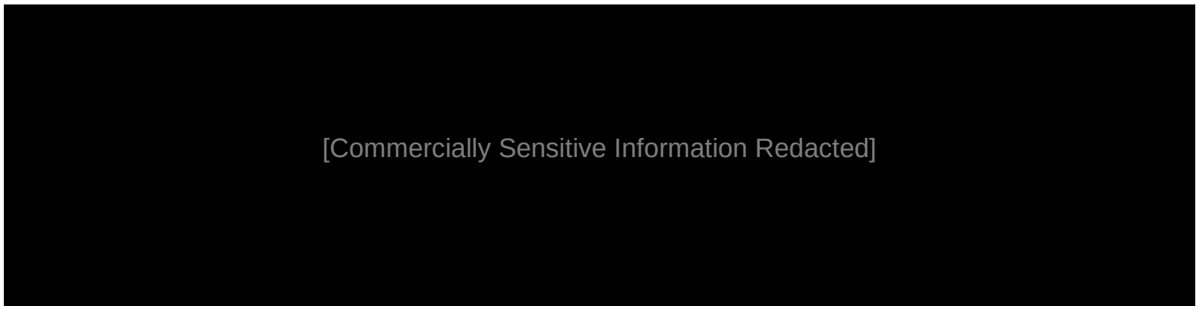

Table 9: Service risk consequences

[Commercially Sensitive Information Redacted]

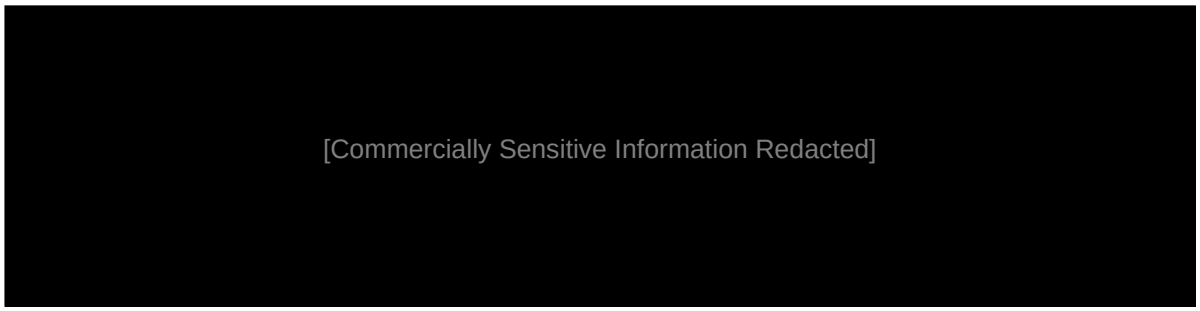

Figure 11: Monetised risk from no proactive investment

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8 Options Considered

[Commercially Sensitive Information Redacted]

8.1 How we have structured this section

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8.2 Modes of Intervention

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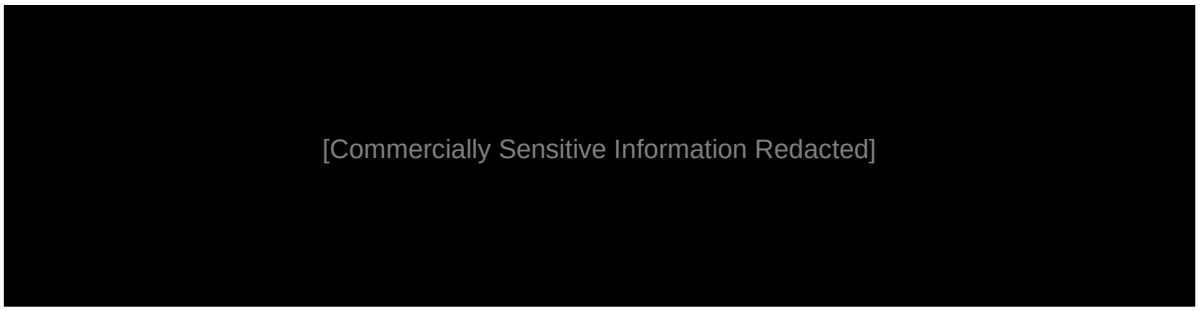

Table 10: Intervention Modes

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8.2.1 Intervention Mode 1: Replace the main via open-cut

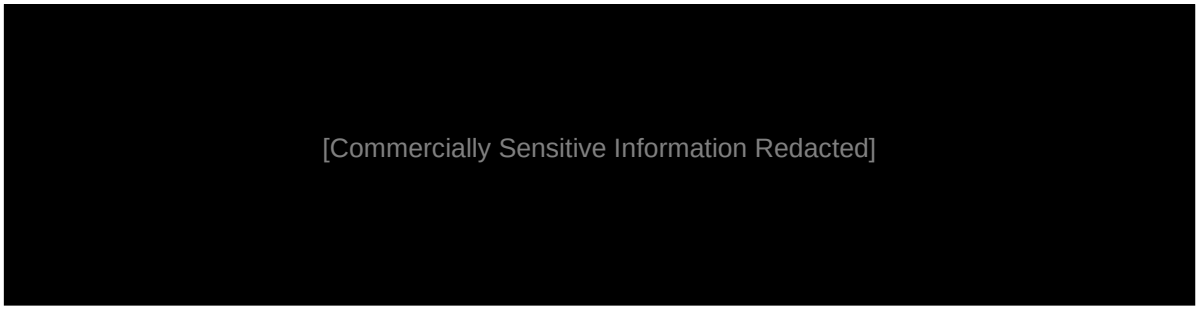

Table 11: Intervention Mode 1

8.2.2 Intervention Mode 2: Replace the main via insertion

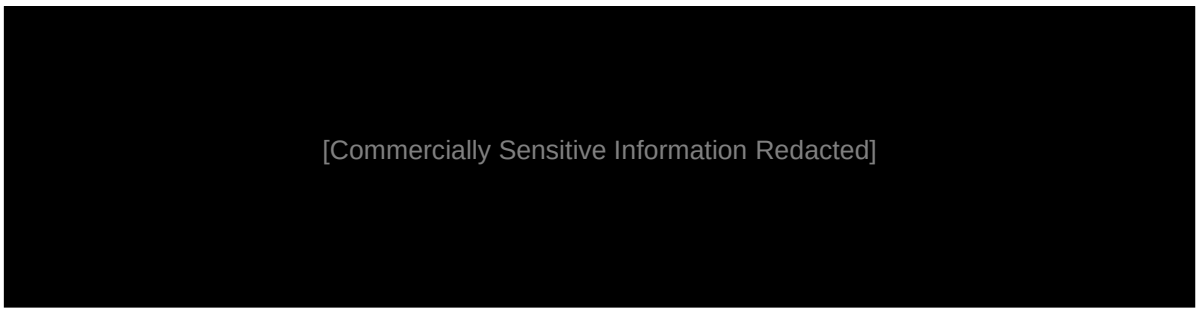

Table 12: Intervention Mode 2

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8.3 Timing Choices

[Commercially Sensitive Information Redacted]

8.4 Options

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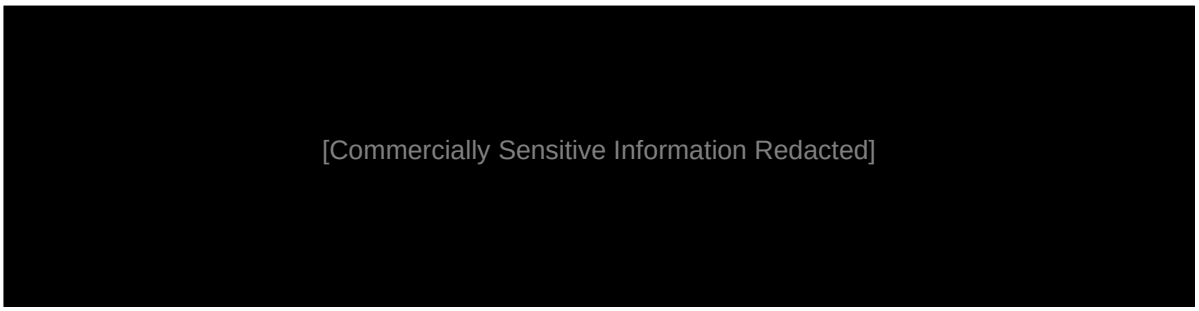

Table 13: Dynamic Growth by Network

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[Commercially Sensitive Information Redacted]

Table 14: Length (km) of ≤2" Steel per km of IMRRP

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[Commercially Sensitive Information Redacted]

Figure 12: Cadent's Vehicle Mounted Emissions Detection Technology

[Commercially Sensitive Information Redacted]

[Commercially Sensitive Information Redacted]

Table 15: Programme options considered

[Commercially Sensitive Information Redacted]

8.4.1 Programme Option 1:

[Commercially Sensitive Information Redacted]

8.4.2 Programme Option 2: IMRRP Replacement in Isolation

[Commercially Sensitive Information Redacted]

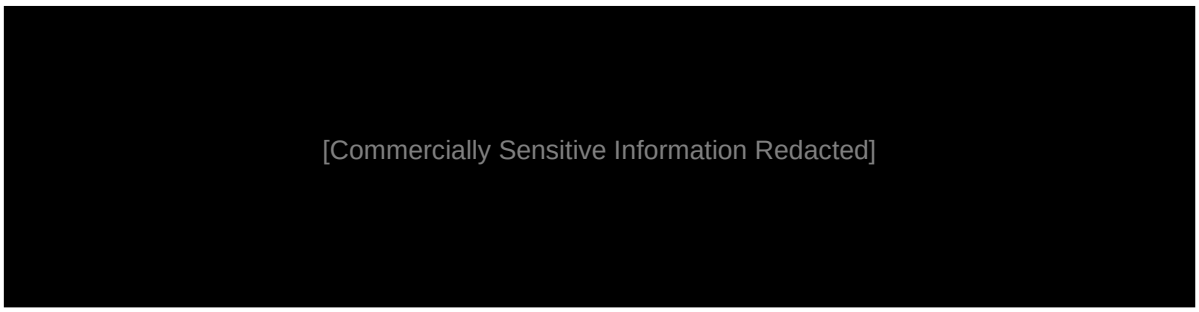

Table 16: Option 2 Volumes (tier 1 iron and ≤2" steel only, associated services excluded)

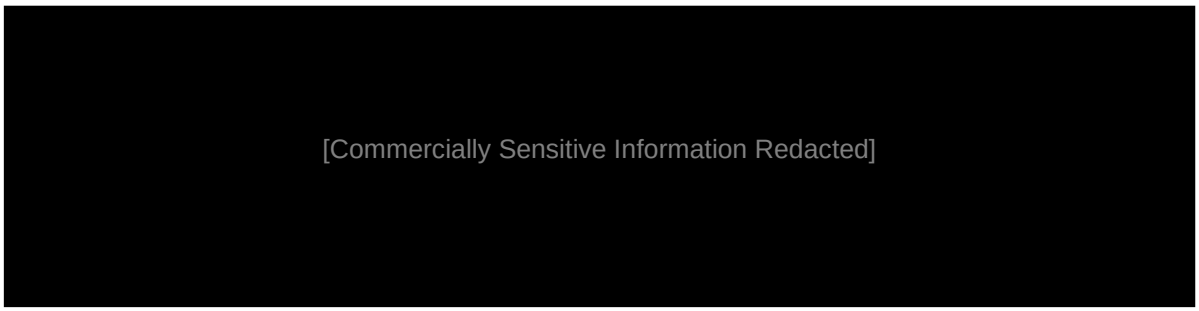

Table 17: Option 2 Volumes - Number of Service Interventions

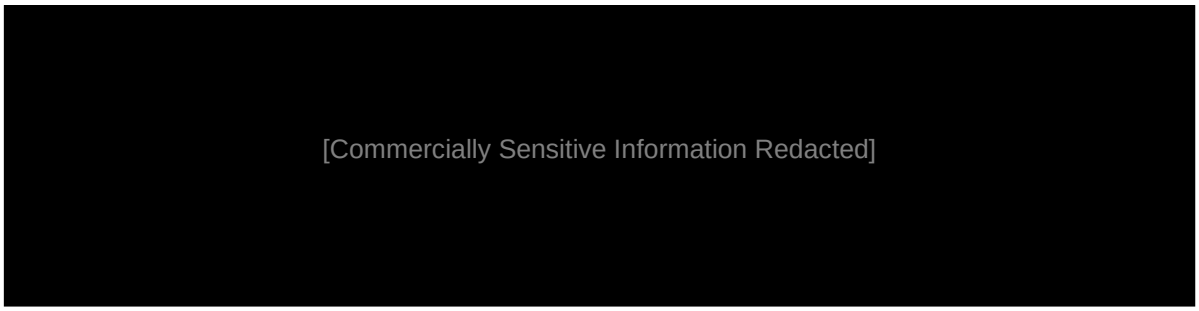

Table 18: Option 2 Costs (tier 1 iron, 2" steel, and associated services)

8.4.3 Programme Option 3:

[Commercially Sensitive Information Redacted]

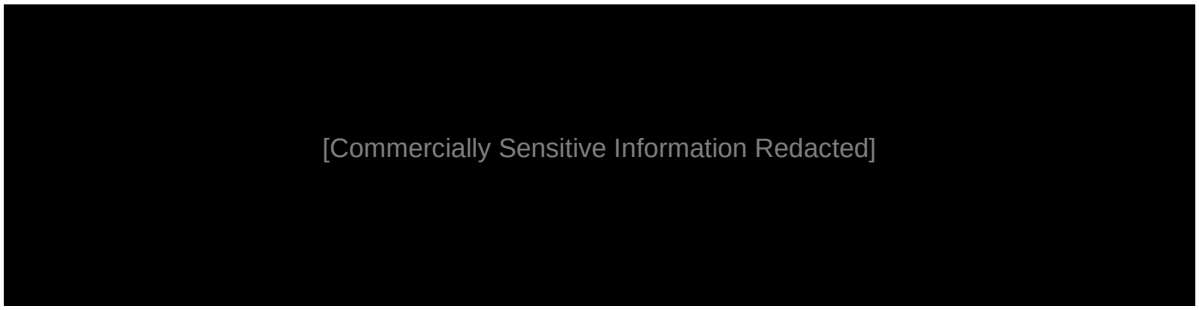

Table 19: Option 3 Volumes (Tier 1 iron, ≤2" steel and asbestos only)

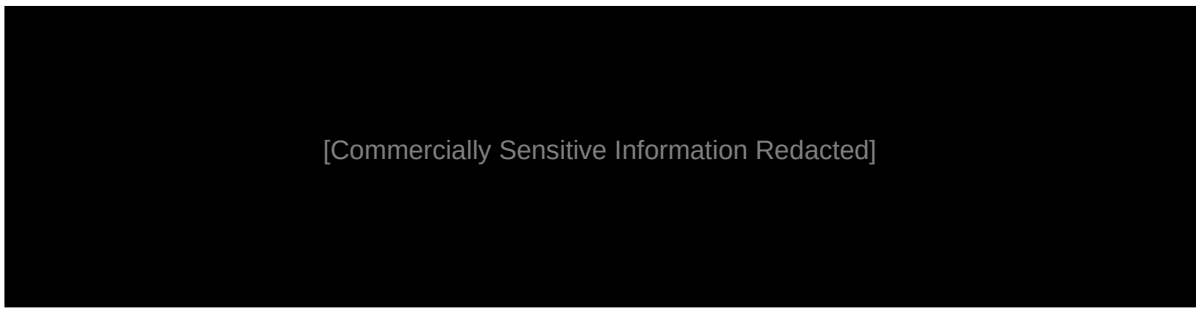

Table 20: Option 3 Volumes - Number of Service Interventions

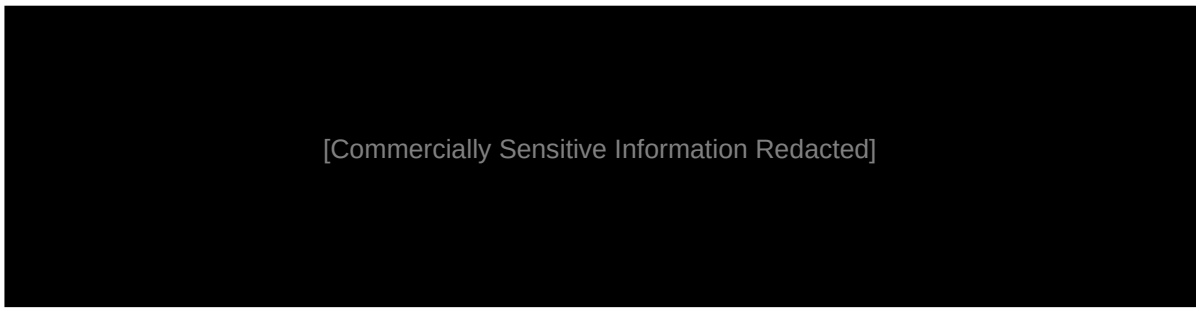

Table 21: Option 3 Costs (Tier 1 iron, ≤2" steel, asbestos and associated services)

8.5 Technical Summary Table: Programme Scenarios

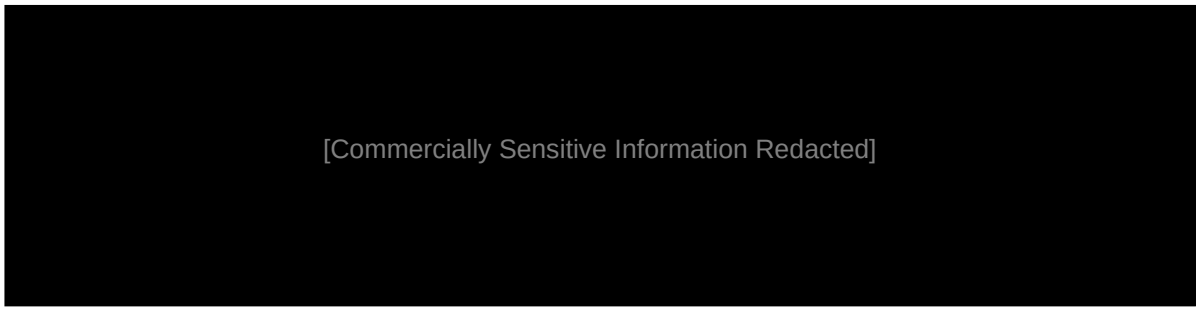

Table 22: Programme Scenarios: Technical Summary Table

9 Business Case Outline and Discussion

9.1 Key Business Case Drivers Description

[Commercially Sensitive Information Redacted]

9.2 Business Case Summary

[Commercially Sensitive Information Redacted]

[Commercially Sensitive Information Redacted]

Table 23: Business Sensitivity Tests Applied

[Commercially Sensitive Information Redacted]

9.2.1 Summary of results

[Commercially Sensitive Information Redacted]

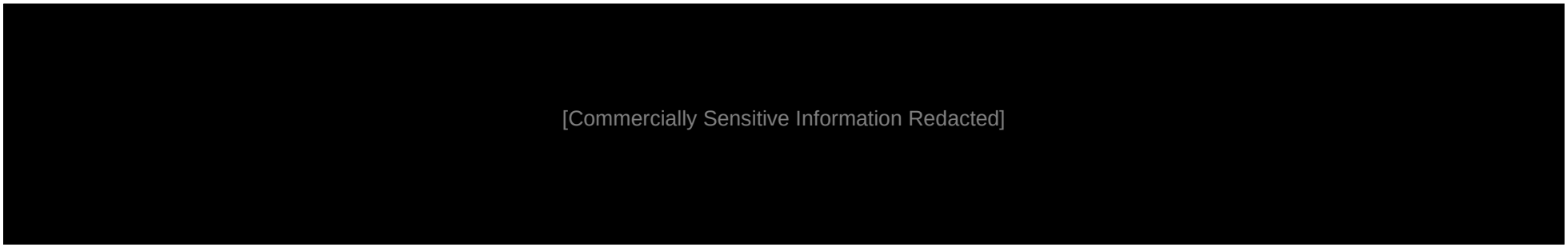

Table 24: CBA Outputs for all scenarios Standard Leakage Model

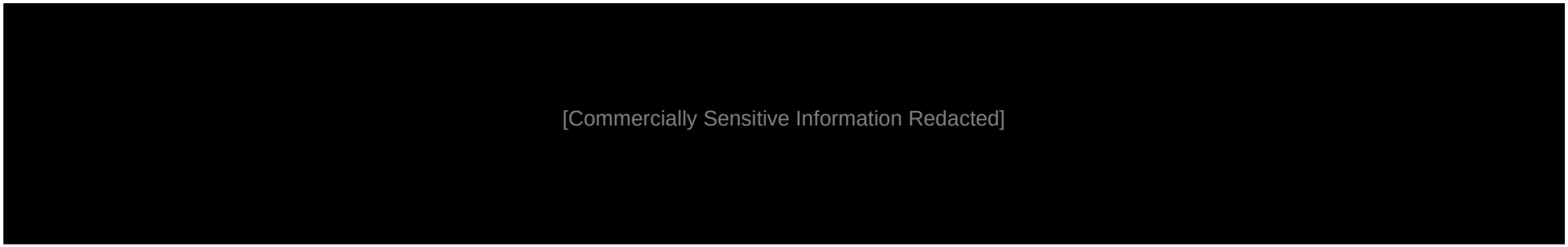

Table 25: CBA Outputs for all scenarios Hybrid Leakage Model

[Commercially Sensitive Information Redacted]

9.2.2 Discussion of results

[Commercially Sensitive Information Redacted]

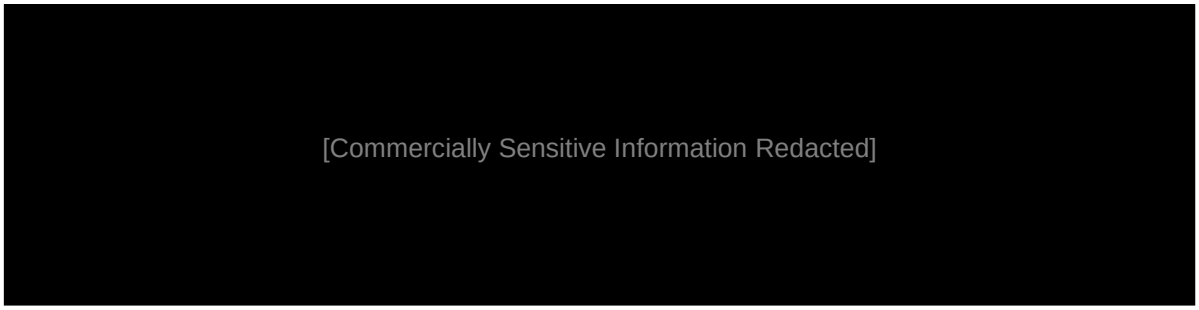

Figure 13: Opex Cost (£m) Comparison Between Options

9.2.3 Conclusions

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10 Preferred Option Scope and Project Plan

10.1 Preferred Option

[Commercially Sensitive Information Redacted]

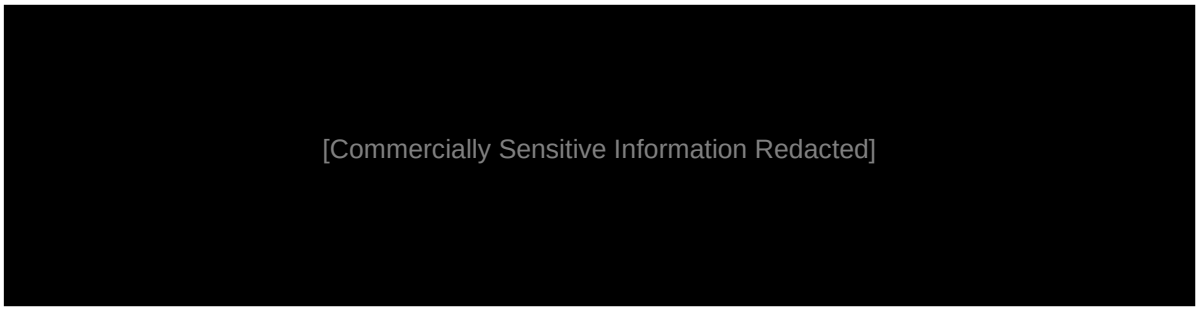

Table 26: Pipe replacement volumes (km) (Tier 1 iron, ≤2" steel, and asbestos)

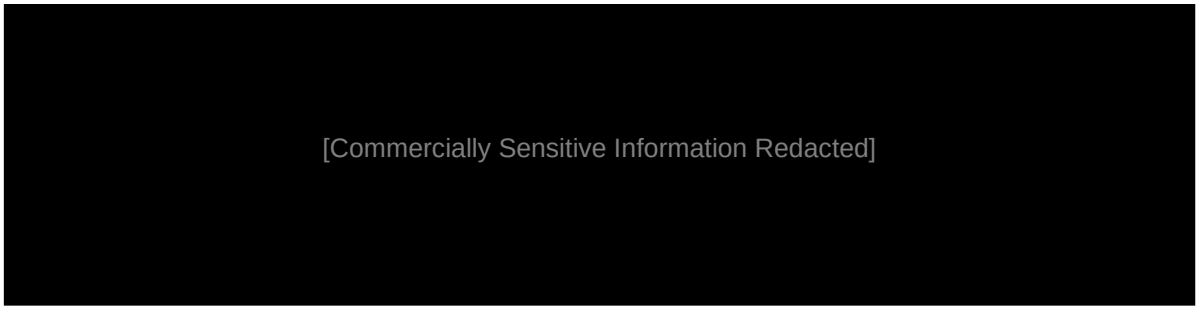

Table 27: Option 2 Volumes - Number of Service Interventions

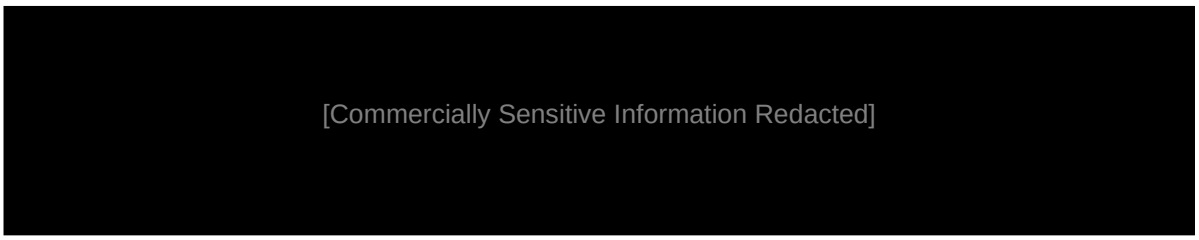

Table 28: Stub volumes

10.2 Asset Health Spend Profile

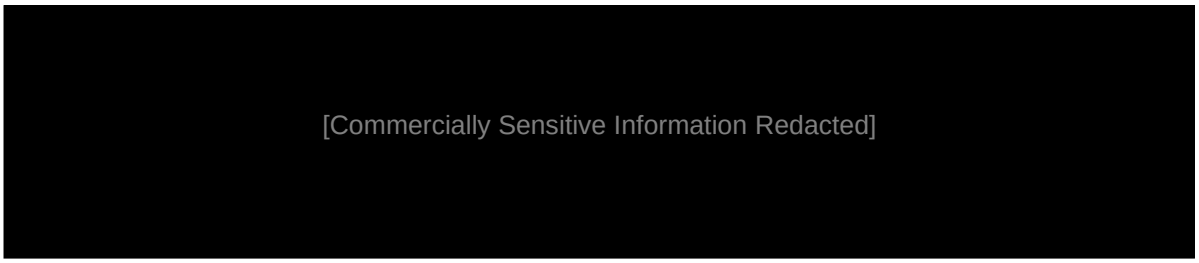

Table 29: Proposed RIIO-3 Spend profile £m (pipe replacement and services associated)

Impact of investment on the asset base

[Commercially Sensitive Information Redacted]

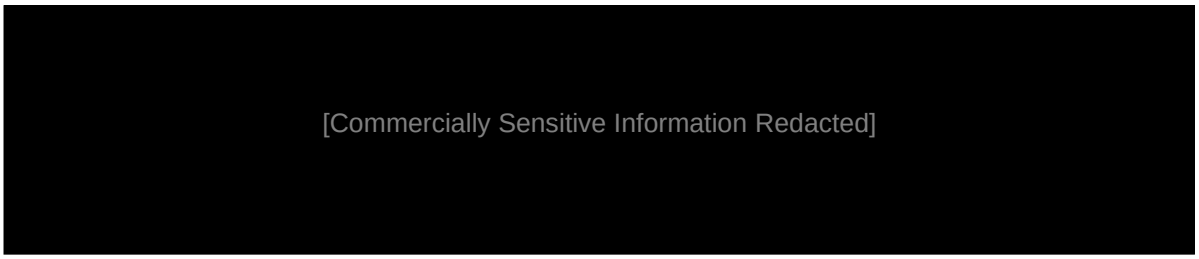

Table 30: Iron and below 2" steel in scope of IMRRP remaining following RIIO-3 investment

10.3 Investment Risk Discussion

[Commercially Sensitive Information Redacted]

10.4 Project Plan

[Commercially Sensitive Information Redacted]

10.5 Key Business Risks and Opportunities

[Commercially Sensitive Information Redacted]

Table 31: Key Risks

10.6 Outputs included in RIIO-2 Plans

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[Commercially Sensitive Information Redacted]

Table 32: RIIO-2 Outputs

[Commercially Sensitive Information Redacted]

11 Regulatory Treatment

[Commercially Sensitive Information Redacted]

12 Glossary

Abbreviation/term	Meaning
HSE	Health & Safety Executive
IMRRP	Iron Mains Risk Reduction Programme
MRPS	Mains Replacement Prioritisation System
LTS	Local Transmission System
MOBs	Multiple Occupancy Buildings
RRP	Regulatory Reporting Process
GiB	Gas in Building(s)
AIM	Asset Investment Manager
PSR	Pipeline Safety Regulations
GSMR	Gas Safety (management) Regulations
NPV	Net Present Value
CBA	Cost Benefit Analysis

Table 33: Glossary Table