Engineering Justification Paper: EJP14

Pipeline Monitoring and Protection

Cadent
Your Gas Network

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1 Summary Table

Name of Project	Pipeline Monitoring and Protection		
Scheme Reference	EJP14		
Primary Investment Driver	Legislative		
Project Initiation Year	*2026*		
Project Close Out Year	*2031*		
Total Installed Cost Estimate (£)	Total installed cost for RIIO-3 work-plan: [cost data]		
Cost Estimate Accuracy (%)	+/-5%		
Project Spend to date (£)	Expenditure in RIIO-2 is forecasted to be [cost data]		
Current Project Stage Gate	This is a rolling programme of investment		
Reporting Table Ref	Table 5.01 LTS and Storage, Table 5.06 and Table 4.04		
Outputs included in RIIO-3 Business Plan	Yes		
Spend apportionment (for RIIO-3 plan)	**RIIO/GD2**	**RIIO/GD3**	**RIIO/GD4**
	[cost data]	[cost data]	[cost data]
Proposed Regulatory Treatment for RIIO-3 Work Plan	Included in base expenditure		

Table 1: Summary Table

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 Chapter 6 of the Workforce and Supply Chain Strategy (Appendix 17).

All prices are pre-efficiency and are in 2023/24 price base, unless otherwise stated.

2 Executive Summary

We undertake a range of proactive pipeline inspection and monitoring activities as part of an integrated pipeline integrity management (PIM) approach. The aim of this approach is to keep the risks associated with operating these assets ALARP (as low as reasonably practicable) to maintain the safety of the public and our employees.

These activities align with the Health and Safety At Work Act 1974 (HASAWA), which sets out the general duties of employers for their employees and members of the public and are a requirement of the Pipeline Safety Regulations 1996 (PSR), specifically Regulations 13 (Maintenance), Regulations 15 (Damage to pipeline) and 16 (Prevention of damage to pipelines) and the Pressure Systems Safety Regulations 2000 (PSSR), specifically Regulation 9 (Examination in accordance with the written scheme) together with interventions required in relation to Regulation 12 (Maintenance). In addition to the primary legislative driver, investment in our pipelines also improves our network resilience and safety and reduces environmental emissions through leaks.

The required monitoring activities range from periodic walking of the High Pressure (HP) and Intermediate Pressure (IP) network to identify changes to the local environment, through to routine aerial and vantage point monitoring of the HP pipelines and monitoring of the HP, IP, MP (medium pressure) and LP (low pressure) Cathodic Protection (CP) systems. The interventions that may result from our monitoring processes can range from maintaining and replacing marker posts and cathodic protection systems, through to extensive risk mitigation activities such as installing pipeline sleeves to provide protection from damage or pressure containment in the event of failure.

Our preferred programme and strategy are consistent with RIIO-2, to continue monitoring our HP and IP pipelines, and repair faults identified through these activities to comply with our PSR 1996 regulations at a cost [cost data] (CAPEX). The table below shows our proposed RIIO-3 and RIIO-4 volumes and costs for monitoring and protection CAPEX activities.

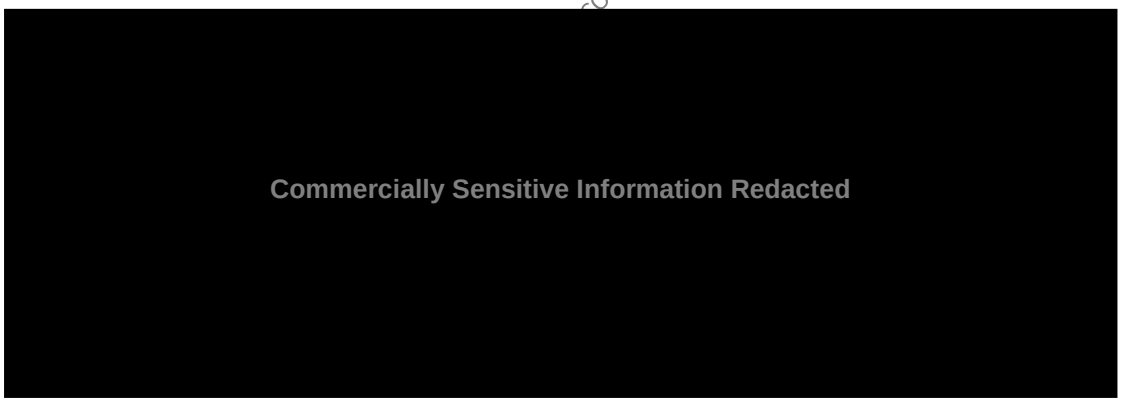

Table 2: proposed RIIO-3 and RIIO-4 volumes and costs

3 Introduction

This paper covers the costs to intervene on faults found during monitoring and inspection activities where the outputs fall outside of expected norms. For example, less than -850mV for CP or less than 600mm cover over pipelines. Inspection (routine and NRMP) and NRMP remedial costs are included in BPDT 4.02 Maintenance.

Monitoring and protection equipment comprises:

- Cathodic Protection (CP) systems, (which are comprised of Transformer Rectifier installations, impressed current system ground beds and sacrificial anode replacement)
- Specific HP pipeline features: marker posts (field boundary and aerial) and Class 1, 2 and 3 sleeves as defined in IGEM/TD/1:

  Class 1: Sleeves to contain pipeline product at pressure in the event of a carrier pipe failure and provide protection against external interference

  Class 2: Sleeves to protect the carrier pipe from external interference

  Class 3: Sleeves to streamline the construction process of the carrier pipe

This paper covers the remediation of the following risks and faults:

- CP: Risks to systems from stray current, missing tests posts, depleted current sources (ground beds and sacrificial anodes) and breach of Reg. 13 of PSR 1996
- Threats to pipeline integrity associated with reduced depth of cover (RDoC)
- Deterioration of sleeves: nitrogen sleeve leakage, sleeve/carrier pipe contact, missing CP monitoring points, defective resistive bonds and breach of Reg. 13 of PSR 1996
- Broken and damaged marker posts: leading to increased risk of pipeline damage from 3rd parties and breach of reg. 16 of PSR 1996

We own and operate 4,931km of HP pipelines and 2,939km of IP pipelines (including 1.6km of reinforced thermoplastic pipe). Failure of these pipelines can have significant consequences for safety and interruptions to supply. In addition to our general obligation to maintain the safety and reliability of the network, our approach to managing and investing in these assets is driven by a legal obligation to comply with PSSR 2000, specifically Regulation 9 (Examination in accordance with the written scheme) together with interventions required in relation Regulation 12 (Maintenance) and PSR 1996, specifically Regulations 13 (Maintenance), Regulations 15 (Damage to pipeline) and 16 (Prevention of damage to pipelines).

Following receiving an improvement notice by the Health and Safety Executive (HSE) in 2015, we have agreed a programme of work to deliver a legislatively compliant CP system. This compromises of; MP/LP and HP/IP interventions, stray current inspections and interventions, and replacement of Remote Monitoring units and battery packs (this document only covers the material investments associated with CP interventions). Failure to maintain our CP systems in a satisfactory manner is a breach of Regulation 13 of PSR 1996 and will result in prosecution against us.

To discharge these obligations, we undertake a range of pipeline monitoring activities as part of an integrated PIM approach. The aim of this approach is to keep the risks associated with operating these assets ALARP to maintain the safety of the public and our employees.

Our approach to PIM aligns and is consistent with recognised industry standards IGEM/TD/1 and IGEM/TD/3.

Consequently, the interventions we make are driven by the need to comply with legislation following assessment and risk-based prioritisation, then the interventions we undertake can be classified as proactive remedial work which is defined below.

Pipeline Monitoring & Protection	Driver
Proactive Remediation	Legislative and/or condition-based driver to mitigate the risk of failure

Table 3: Intervention Driver

We protect our pipelines from the hazards associated with corrosion and damage in several ways including:

- For steel, the use of factory and field applied coating systems
- The installation of CP systems
- The application of plant protection processes

We also protect our pipelines from the risk of damage from third party interference or changes to the environment the pipe is in by operating a range of proactive and reactive plant protection processes.

The proactive processes include survey and monitoring activities, such as periodic line walking of HP and IP pipelines (with a frequency of 4 and 10 years respectively, based on risk and underpinned by industry standards), to identify changes to the local environment including, for example, ground movement, significant variations in the depth of cover, or encroachments including situations where the pipe has been built over. Additionally, routine fortnightly aerial surveys of most HP pipelines are undertaken together with vantage point surveys for those sections which cannot be flown.

Where it is identified that a pipeline section is potentially at risk from ground movement, or some other form of external loading, then these will be assessed and appropriate action taken.

This paper considers the technical need for investment in pipeline monitoring and protections and the resulting pipeline interventions to manage pipeline integrity risks. The investment lines included in this EJP are:

- Cathodic Protection
- Reduced Depth of Cover
- Sleeves
- Marker post installation (NRMP OPEX)

To ensure consistency with our legislative obligations and because these assets do not have a direct impact on service risk and performance, we have not attempted to justify our chosen strategy using a Cost Benefit Analysis (CBA). This paper has therefore not used the asset model to support any failure modes, risk reduction or CBA, as discussed and agreed with Ofgem during our bilateral dated September 2024.

4 Equipment Summary

The pipeline assets included in this paper comprise of the following. (Please note, this investment case is for the response to in period inspection findings and therefore is not managed by health scores).

4.1 Cathodic Protection

This covers the investment case methodology for interventions on our High, Intermediate, Medium and Low Pressure (HP, IP, MP, LP) CP systems. These systems extend the life of our assets, preventing deterioration through corrosion and ensure compliance with PSR 1996.

We have a comprehensive rolling programme of inspections, that enables us to make risk-based decisions on critical remediation. Interventions typically take the form of repair or replacement to test posts, electrical components, transformer rectifiers, sacrificial anodes and ground beds. Activity is high volume, low cost. Tables 1-4 below list the number of CP Schemes per pressure tier per region:

HP Pipes & Sites		
Region	**CP Schemes Total**	**Total number of Test Posts**
East of England	416	5,860
North London	136	1,622
North West	217	3,709
West Midlands	93	1,518
Total	**862**	**12,709**

Table 4: Total number of HP CP test posts per region

IP Pipes & Sites		
Region	**CP Schemes Total**	**Total number of Test Posts**
East of England	620	4,745
North London	53	815
North West	172	1,750
West Midlands	65	727
Total	**910**	**8,037**

Table 5: Total number of IP CP test posts per region

MP Pipes & Sites		
Region	**CP Schemes Total**	**Total number of Test Posts**

MP Pipes & Sites		
East of England	1,197	6,601
North London	248	1,408
North West	395	1,553
West Midlands	132	806
Total	**1,972**	**10,368**

Table 6: Total number of MP CP test posts per region

LP Pipes & Sites		
Region	**CP Schemes Total**	**Total number of Test Posts**
East of England	196	751
North London	22	88
North West	106	346
West Midlands	15	46
Total	**339**	**1,231**

Table 7: Total number of LP CP test posts per region

We have a rolling inspection programme which allows performance comparison period on period. The CP scheme inspection frequencies as per, which is the basis of our funding request for the period. This policy aligns with BS EN 12954: General Principles of Cathodic Protection of Buried or Immersed Onshore Metallic Structures.

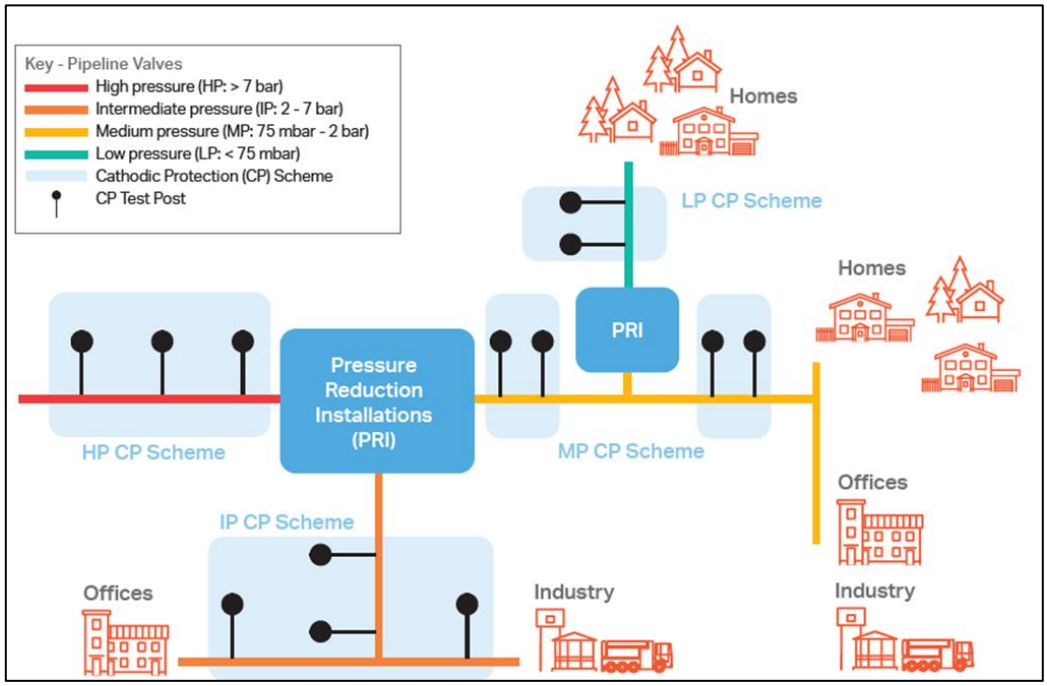

Figure 1: CP schemes included within this investment case

4.2 Sleeves

Sleeves are designed to provide either pressure containment in the event of a failure of the pipeline, additional protection to the pipeline at crossings or to assist in the construction process. We have an obligation under PSR 1996 Regulation 13 to maintain its pipeline assets.

There is a risk of corrosion of the pipeline occurring within the sleeve annulus which could potentially lead to a HP gas escape. Such a scenario could put the safety of the public, our employees and contractors, and the security of supply to customers at risk. This risk is heightened particularly on pipelines that are not piggable as in these situations the condition of the sleeve is examined and not the gas carrying pipe during the alternative overland survey.

We have over 2,041 sleeves on HP pipelines of which approximately 291 are filled with nitrogen (used to prevent the establishment of conditions that support corrosion) utilising a variety of end sleeve types. The current maintenance practice is primarily focused on monitoring and remediating both CP systems installed on steel sleeves and nitrogen (N2) fill levels.

A summary of the number of HP pipeline sleeves in each region is shown below in Table 5, which also provides the split by pipeline inspection type (piggable or non-piggable). Table 6, also below, provides a summary of the number of HP pipeline sleeve types by region.

Region	Piggable	Non-Piggable	Overall
East of England	705	137	**459**
North London	364	44	**408**
North West	353	46	**399**
West Midlands	329	63	**392**
Total	**1,751**	**290**	**2,041**

Table 8: HP Pipeline Sleeve population by region and pipeline inspection type

	Sleeve Type			
Region	Steel	N_2	Other	Total
East of England	307	61	474	**459**
North London	318	61	29	**408**
North West	281	118	0	**399**
West Midlands	229	51	112	**392**
Total	**1,135**	**291**	**615**	**2,041**

Table 9: HP Pipeline Sleeve population by region and sleeve type

4.3 Reduced Depth of Cover (RDoC)

Line walking is an above ground survey that records depth readings at a maximum interval of every 50 meters, as well as at all significant features such as ditch crossings, road crossings, rail crossings, water courses or significant change in gradient or type of land. Those individual depth measurements are categorised as either Red, Amber, or Green as shown in the following table:

Pipeline Depth (m)	Category
<= 0.6	Red
>0.6 <0.9	Amber
>=0.9	Green

Table 10: Depth measurement categories

Line walking is carried out at regular frequencies to meet our minimum standards. For our HP systems, the full length of the pipeline is surveyed every four years and for our Intermediate Pressure Pipelines, the full length is surveyed every ten years.

Line walking may also be utilised for the management of identified RDoC sites on the 2 bar and below pipelines. Dependent on the action required, monitoring is required to ensure the restrictive actions on high-risk sites are being adhered to until a long-term solution has been achieved.

Where areas of RDoC, third Party encroachments and right of way clearance are identified (which can be safety, engineering, legal and compliance challenges), there is a requirement to carry out pipeline integrity assessments and remediation.

The table below shows our forecast outturn for RIIO-2 volumes and costs for monitoring and protection CAPEX activities.

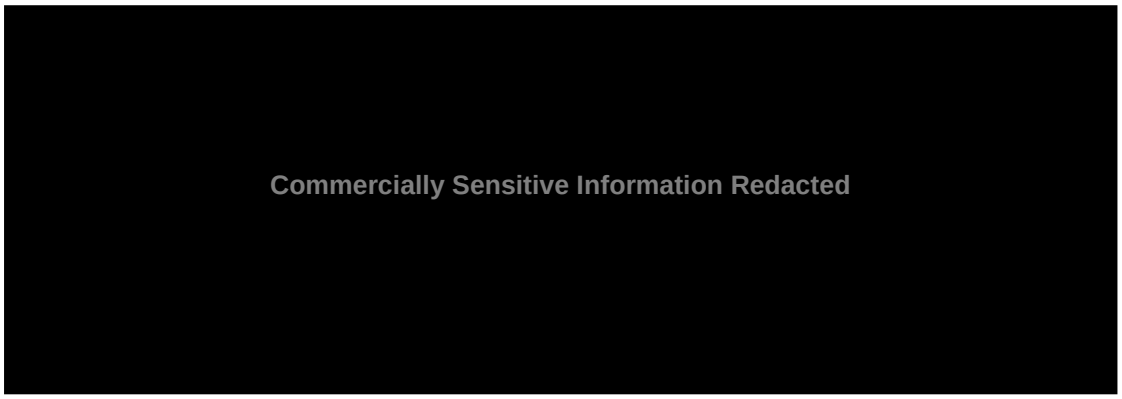

Table 11: Estimated RIIO-2 (Capex) Volumes and Costs

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5 Problem Statement

The investment driver for these assets is to ensure legislative compliance by mitigating risks caused by asset deterioration, and the failure of our HP pipelines due to deterioration of our pipeline protection systems.

These pipeline protection systems comprise:

- Cathodic Protection systems: These systems slow the deterioration of buried steel pipes. The effectiveness of cathodic protection systems can be adversely affected by stray currents from third parties which can then have a deleterious effect on the pipeline being protected
- Sleeves: There are three types of sleeves that protect our pipelines. Classes 1, 2 and 3 as defined in IGEM/TD/1 (containment, protection and construction). Class 1 sleeves are filled, either by nitrogen or grout, whereas Class 2 and 3 sleeves may be nitrogen filled, grouted or left empty. If these deteriorate, the pipeline integrity may be put at risk
- Marker Posts: These are a legislative requirement to ensure that landowners and third parties are aware of the presence of a HP / MP / IP pipeline, thus protecting it from damage
- The level of ground cover above the pipe: When pipes have insufficient ground cover they have a greater risk of damage from third parties. The ground cover also helps dissipate the load on the pipe from vehicles passing over-head

It is crucial that we have a cost-effective way to manage and maintain these pipeline protection assets, through effective inspection and interventions. Asset deterioration causes poor performance and safety risks. This in turn could lead to supply interruptions, loss of containment, with associated environmental impacts and fire and explosion risks to employees and members of the public.

PSR 1996 requires us to monitor and maintain our Local Transmission System (LTS) pipeline integrity management processes and systems. We have a legislative obligation to carry out a wide range of periodic surveys which identify faults with pipeline protection systems or pipeline integrity risks, once identified we have an obligation to investigate the root-cause of the risks and carry out suitable remediation.

5.1 What Happens If We Do Nothing?

The principal risks associated with different failure modes (ruptures, leaks, explosions and loss of supply events) to a pipeline would lead to us not meeting legislative obligations, compromising security of supply and lead to a failure to meet Health and Safety requirements for both Public and Cadent Personnel.

The following summarises the consequences of doing nothing:

- Safety/Legislative: by not maintaining our pipeline assets, they pose a safety risk due to the fire and explosion risk from leakage. Furthermore, we would be in breach of PSSR 2000, specifically Regulation 9 (Examination in accordance with the written scheme) together with interventions required in relation Regulation 12 (Maintenance) and the PSR 1996 specifically Regulations 13 (Maintenance), Regulations 15 (Damage to pipeline) and 16 (Prevention of damage to pipelines)
- Environmental: any leaks will result in a gas release to the atmosphere, with a resulting impact to carbon emissions
- Security of Supply: pipeline failure could cause asset or site outage, resulting in customer supply interruptions. Depending on the location and network configuration, this could impact hundreds of thousands of customers

- Financial: any pipeline failure will have resulting costs to respond and mitigate the failure, to re-establish operation, repair and restore supply, this could run into millions of pounds. If we don't intervene on time the cost will increase due to further deterioration of the condition of the asset

5.2 Key Outcomes and Understanding Success

[section redacted]

5.3 Narrative Real-Life Example of Problem

[section redacted]

Figure 2: Replacement of damaged CP Marker Post

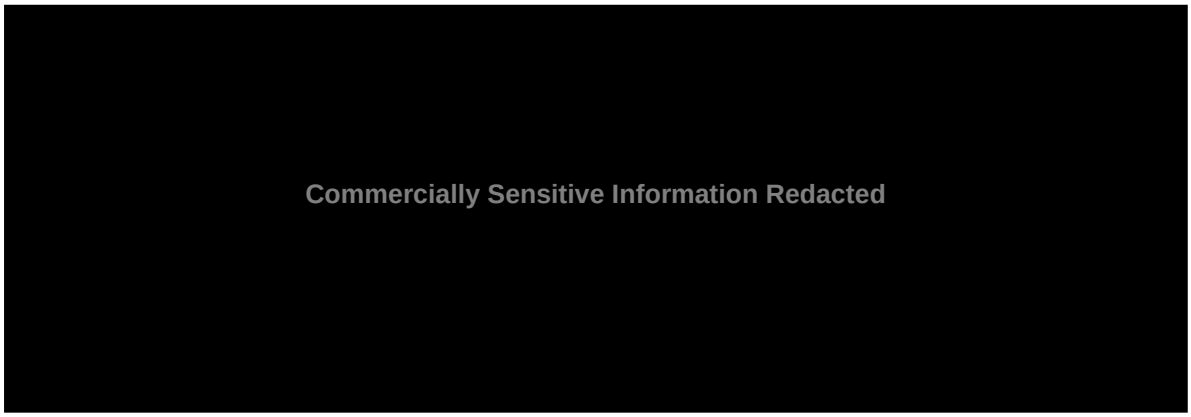

Figure 3: Ditch remediation, new fencing and deeds of variation following RDoC

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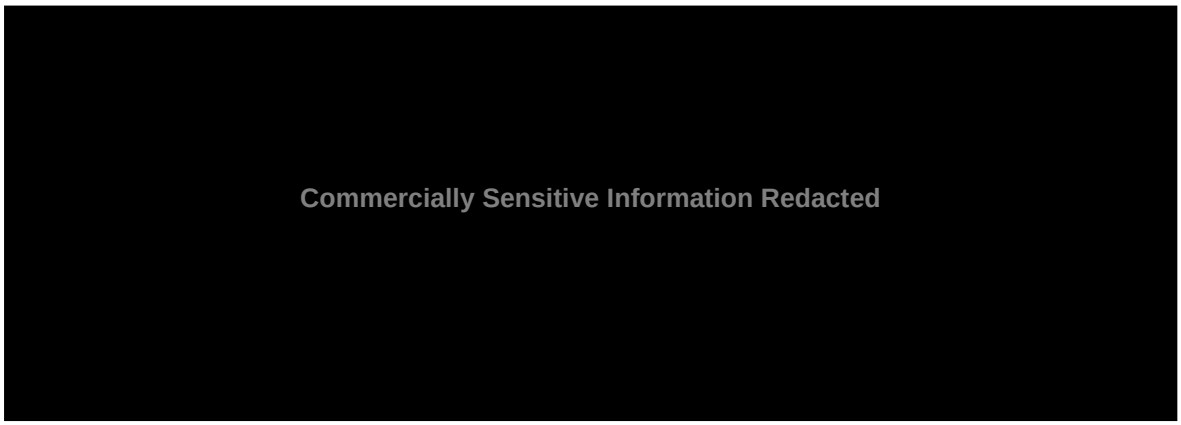

Figure 4: Test post installation excavation, transformer rectifier and vertical CP ground bed installation

5.4 Project boundaries

[section redacted]

6 Probability of Failure

6.1 Failure modes

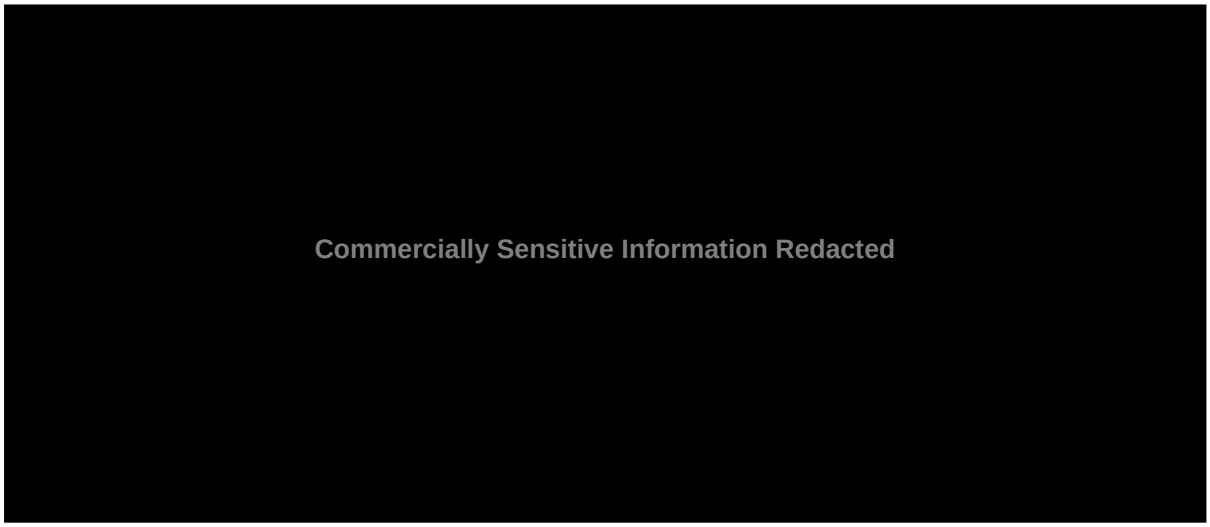

Table 12: Associated failures, fault types and consequences for pipeline monitoring and protection

6.2 Minimum Standards Used to Inform Intervention

[section redacted]

6.3 Probability of Failure Data Assurance

[section redacted]

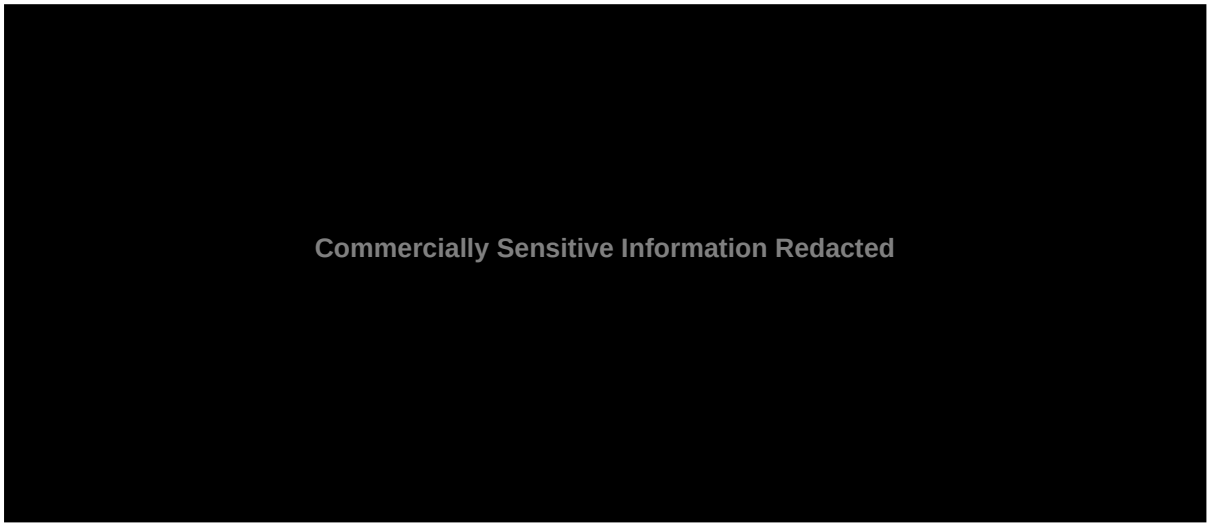

Figure 5: The legislative framework that outlines Cadent's legislative obligations and fulfilment through internal policies and procedures related to the monitoring and protection TNC's

7 Consequence of Failure

7.1 Legislative obligations

[section redacted]

7.2 Health and Safety

[section redacted]

7.3 Environment

[section redacted]

7.4 Supply and Demand Scenario Discussion and Selection

[section redacted]

8 Options Considered

8.1 How we have structured this section

[section redacted]

8.2 Modes of Intervention

[section redacted]

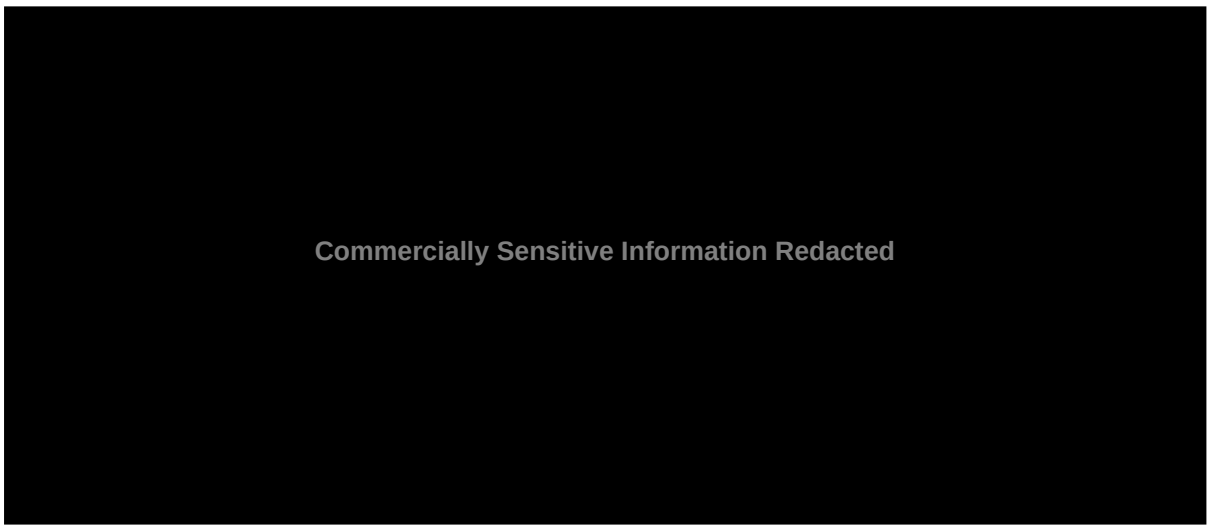

Table 13: Intervention options considered

8.3 Timing Choices

[section redacted]

8.4 Options

[section redacted]

9 Business Case Outline and Discussion

9.1 Key Business Case Drivers Description

[section redacted]

9.2 Business Case Summary

[section redacted]

9.3 Conclusions

[section redacted]

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10 Preferred Option Scope and Project Plan

10.1 Preferred Option

[section redacted]

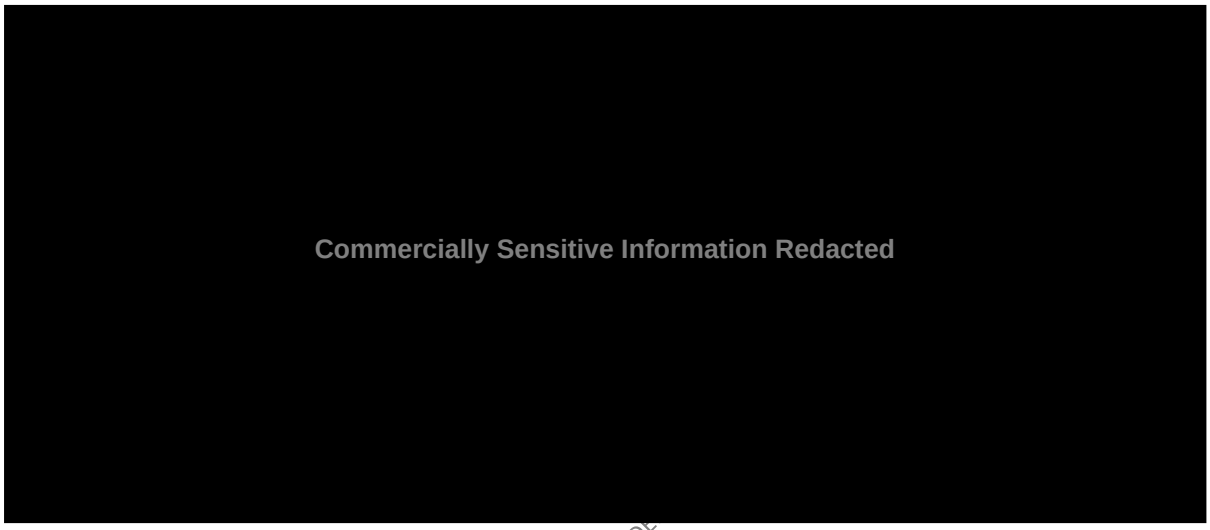

Table 14: Proposed estimate RIIO-3 workload summary

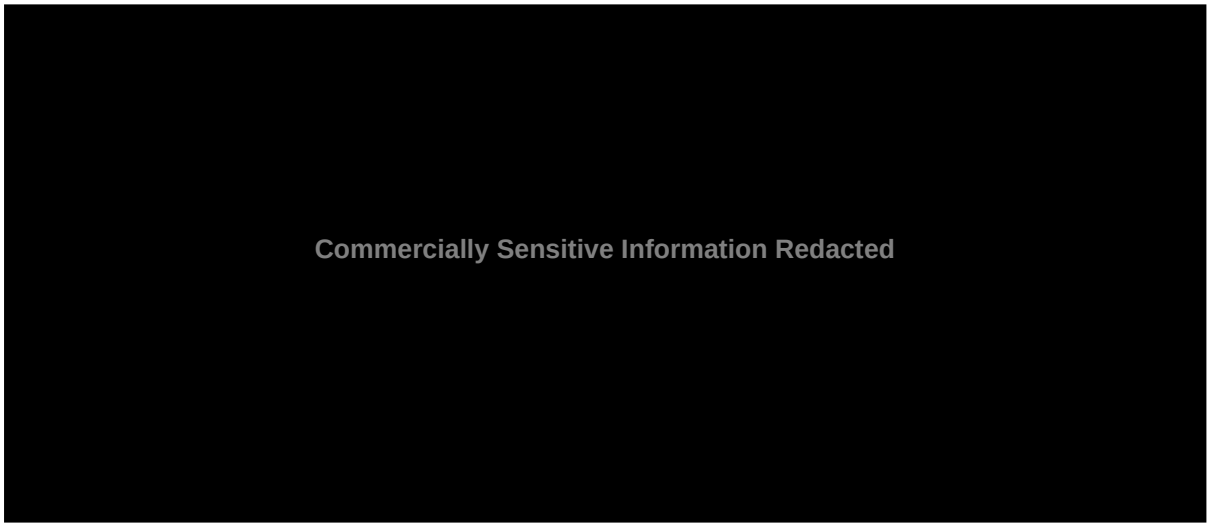

Table 15: Proposed RIIO-3 intervention volumes by region

10.2 Asset Health Spend Profile

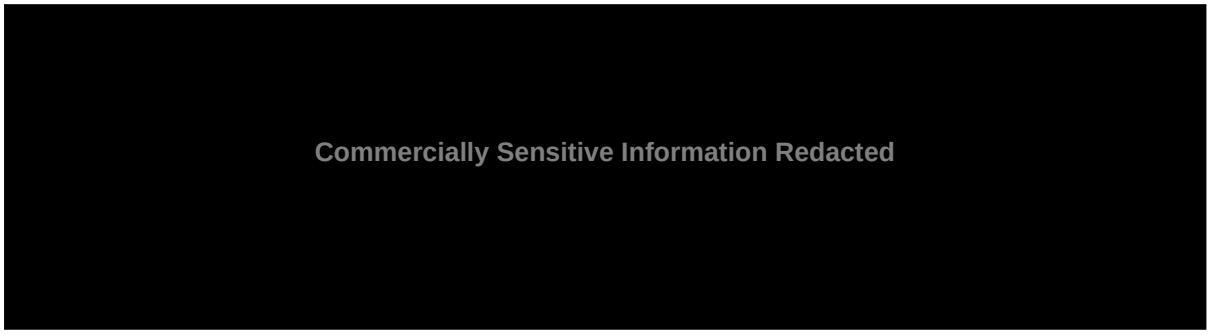

Table 16: Proposed RIIO-3 CAPEX expenditure by region

10.3 Investment Risk Discussion

[section redacted]

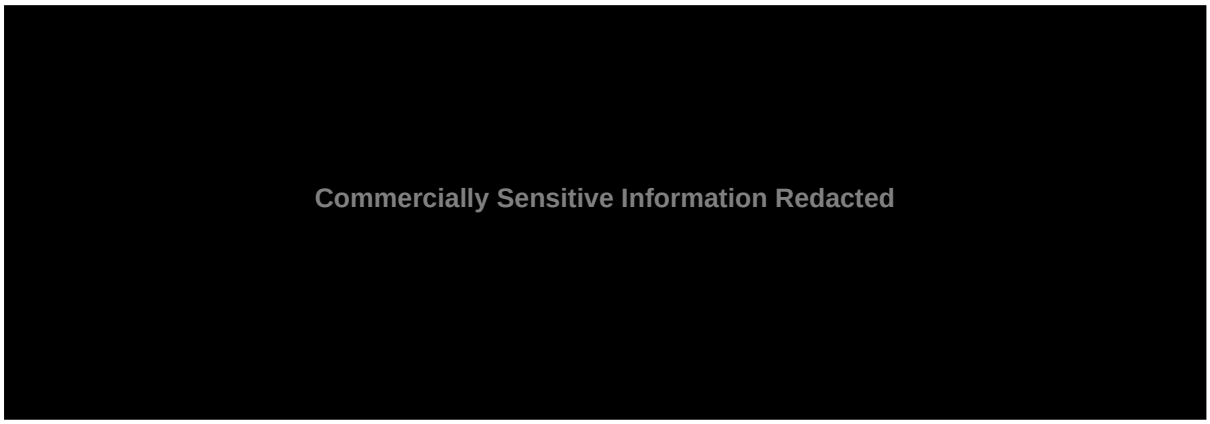

Table 17: Business risks identified to have a potential impact to this investment case

10.4 Project Plan

[section redacted]

10.5 Key Business Risks and Opportunities

[section redacted]

10.6 Outputs included in RIIO-2 Plans

[section redacted]

11 Regulatory Treatment

[section redacted]

12 Glossary

Term	Definition
BPDT	Business Plan Data Table
CP	Cathodic Protection
CBA	Cost Benefit Analysis
EJP	Engineering Justification Paper
FES	Future Energy Scenarios
HP	High Pressure
IP	Intermediate Pressure
LP	Low Pressure
LTS	Local Transmission System
MP	Medium Pressure
NAMS	Network Asset Management Strategy
PSR	Pipeline Safety Regulations
PSSR	Pressure Systems Safety Regulations

Table 18: Glossary Table