Cadent
Your Gas Network

Diversions and Loss of Land Development Claims Re-opener Submission

January 2024

Classification: Confidential

Ofgem Requirement

The table below outlines where each chapter of this application relates to Special Condition 3.20 of our Gas Transporter licence as well as Ofgem's requirements as set out in Special Condition 9.4.

Ofgem requirement	Application chapter
GT licence – Special Condition 3.20 Diversions and Loss of Development Claims policy Re-opener	
Circumstances for applying to Ofgem for re-opener (Para 3.20.6) Application requirements (para 3.2.7)	Chapter 1.0 – Exec Summary Chapter 2.0 – Alignment with our RIIO-GD2 Business Plan Chapter 3.0 - The relocation of existing gas assets to accommodate third-party works for mains and associated services Chapter 3.1 – Trigger 1 – Scope, trigger & needs Case Chapter 3.2 – Trigger 1– Consideration of options Chapter 3.3 – Trigger 1 – Options selection Chapter 3.4 - Trigger 1 – Cost Information Chapter 3.5 - Trigger 1 – Cost Benefit Analysis & Engineering Justification Chapter 4.0 - The diversion of gas assets due to adverse environmental factors Chapter 4.1 – Trigger 2 – Trigger and needs Case Chapter 4.2 – Trigger 2– Consideration of options Chapter 4.3 – Trigger 2 – Options selection Chapter 4.4 - Trigger 2 – Cost Information Chapter 4.5 - Trigger 2 – Cost Benefit Analysis & Engineering Justification Chapter 5.0 - Rectifying damage to pipelines from soil erosion Chapter 5.1 – Trigger 3 – Scope, trigger and needs Case Chapter 5.2 – Trigger 3– Consideration of options Chapter 5.3 – Trigger 3 – Options selection Chapter 5.4 - Trigger 3 – Cost Information Chapter 5.5 - Trigger 3 – Cost Benefit Analysis & Engineering Justification Chapter 6.0 - Appendices Chapter 6.1 – Supporting Documents Chapter 6.2 – Glossary of Terms
RIIO-GD2 Re-opener Guidance and Application Requirements Document: Version 3 (Feb 2023)	
Requirements for the content of re-opener applications: Introduction (para 3.1)	Chapter 1.0 – Exec Summary

Point of Contact

The table below provides a point of contact for this re-opener application should you wish to discuss any elements of it or have further questions. To ensure any correspondence is picked up in a timely manner, should the point of contact be out of office, please also copy in our mailbox referenced below.

Name	Position	Email	Telephone
[Sensitive Data]	[Sensitive Data]	[Sensitive Data]	[Sensitive Data]

Chapter 1.0
Executive Summary

This paper is Cadent's application to the Authority requesting an adjustment to our RIIO-GD2 allowances under the Diversion and Loss of Land Development Claims Re-opener mechanism. The modification is necessary to undertake diversion and structural removal works to maintain the safe operation of networks, enable growth and to ensure we can continue to access our assets following third-party encroachment/development. This work is triggered by third party demand or changing environmental factors and is consequently difficult to forecast. Our requirement to undertake such work is driven by responsibilities under the Pipelines Safety Regulations 1996 (PSR), to be able to actively access and maintain our pipes and thereby manage health and safety risks and interruptions to supply caused by gas escapes and/or pipes collapsing.

Cadent Gas Limited ("**Cadent**") are making a re-opener submission under Special Condition 3.20 Diversions and Loss of Development Claims re-opener policy, Part A, Para 3.20.4: (a) Diversions Costs; (b) Loss of Development Claims or (c) Costs of diverting gas assets due to adverse environmental factors.

The Proposed Investment and Adjustment Size:

Chapters 3 to 5 of this Re-opener application are split as per the scope of the Re-opener license condition:

1) Chapter 3: Accommodation of third party works
2) Chapter 4: Adverse environmental factors
3) Chapter 5: Loss of Development Claims

The costs associated with these triggers have led to costs which exceed the materiality threshold in East of England, North London, North West, and West Midlands

	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	Total expected spend (£m)
EN (£m)						
NL (£m)						
NW (£m)						
WM (£m)						

Figure 1 – Total adjustment value, reference in "Cost Summary – Re-Opener Tab" in Appendix –1 Diversions Re-Opener Finance Tracker

	EN (£m)	NL (£m)	NW (£m)	WM (£m)	Total (£m)
Accommodation of third party works					
Adverse environmental factors					
Loss of Development Claims					

Figure 2 – Total adjustment value, by the scope of the reopener

Chapter 3: Accommodation of third party works

Under the PSR Cadent has a clear duty to ensure our pipelines are maintained in a state of efficiency, proper working order, and good repair. This responsibility is particularly pertinent in instances of third-party encroachment or nearby infrastructure work near or on our mains, pipelines, and service pipes. Such scenarios carry substantial risks, including potential explosions, fires, and harm to the integrity of our gas assets. When external structures interfere with our pipelines, they can exert excessive pressure, escalating the likelihood of failures and often necessitating expensive diversion measures. Furthermore, encroachments limit our ability to access our assets which we need to do to comply with PSR.

The scope of work

Our approach to addressing third-party encroachments or developments involves either diverting the gas asset or removing the encroaching structure. These resolutions are assessed individually with the preferred option being the most efficient and cost-effective option for each scenario.

We have provided details for diversions and structural removals in instances of third-party encroachment of our assets, where actual costs have been incurred, a forecast cost, and the methodology employed. However, for resolutions involving the relocation of encroaching structures, we propose an additional re-opener window at the close of the RIIO-GD2 period. This proposal responds to the challenges of forecasting costs for this type of work.

Chapter 4: Adverse environmental factors

This chapter includes two projects that fall within the scope of this trigger: [Security Data] and [Security Data].

1) **[Security Data]**:

Cadent owns and operates the [Security Data] High-Pressure Gas Pipeline along the [Security Data]. This area is known for its unstable embankment.

Historically, the pipeline has suffered leakages from stress corrosion cracking, notably between 1975 and 1979. Factors like increased traffic and environmental changes like tree movement and root decay have exacerbated these issues, leading to further leak and embankment instability.

Reports from 2008 to 2019 have been pivotal in assessing the pipeline's condition. These indicate significant environmental impact and stability concerns, guiding our decision towards a pipeline diversion to ensure its integrity and the security of the gas supply.

2) [**Security Data]**:

This project focuses on providing erosion protection for five of Cadent's pipelines crossing the [Security Data], which are at risk due to riverbed erosion. Two pipelines, [Security Data], are already exposed. Erosion and fluctuating water levels, especially in this tidal and navigable section, pose significant risks of further damage and exposure. The project aims to prevent potential integrity issues from escalating by protecting the pipelines using protective rock armour [Sensitive Data] which is the most efficient and cost-effective option.

Chapter 5: Loss of development claims

Our loss of development submission relates to four claims that have been settled where we have incurred actual costs. [Sensitive Data]. The deed of variation for each claim is outlined with associated options considered with a summary of the valuation of each claim. [Sensitive Data]. We have also provided a cost forecast for future claims where we have the claim value and an option for an additional Re-Opener window to recover costs for claims where a notice of approach has been received but we are currently awaiting to receive a claim amount.

Chapter 2.0
Alignment with our RIIO-GD2 business plan

Chapter 2.1 – Alignment with our RIIO-GD2 business plan

Cadent's gas network plays a critical role in delivering affordable, safe, and reliable heating to over 80% of domestic homes and in fuelling major industry, businesses, schools, and hospitals in England. The main aim of the RIIO-GD2 business plan is to be at the forefront of shaping and delivering the road to Net Zero through facilitating clean gas and demonstrating a hydrogen pathway for our current and future consumers.

The high-level objectives of the business plan are:

- Delivering a resilient network to keep the energy flowing safely and reliably.
- Providing a quality experience to all our consumers, stakeholders, and communities
- Tackling climate change and improving the environment

UM	Customer need	Driver of uncertainty	Reasons for excluding from base plan
Diversions	Consumers and stakeholders require us to undertake diversions works to maintain the safe operation of our network, and to ensure we can continue to access the network following third-party encroachment. Our requirements to undertake such work is driven by responsibilities under the Gas Pipeline Safety Regulations to be able to actively access and maintain our pipes and thereby minimise health and	There was uncertainty in the volume of work we were required to undertake in RIIO-GD2. Diversions are triggered by customer demand, which may materialise in period without forewarning. Developer's plans, and therefore requirements, are susceptible to change at short notice. There was also uncertainty over the individual costs of work, especially in relation to non-chargeable diversions. This is compounded by uncertainty in land	Both volume and unit cost risk drove uncertainty in constructing a total cost estimate to include in the base plan. Instead, we included 80% of the minimum volumes of diversions undertaken in RIIO-1 in our base plan on an annual basis. Expenditure beyond this point is highly dependent on growth in customer demand. We did not include a full allowance for diversions in our base plan, as there was a risk that this will differ from actual required expenditure if actual growth volumes differ from our assumptions, creating

	safety risks and interruptions to supply caused by gas escapes and/or pipes collapsing.	access rights and associated legal costs.	opportunity for losses or windfall gains to consumers and Cadent.

Figure 3: Evidencing forecast uncertainty for our proposed UMs to address demand uncertainty

The requirement to undertake pipeline diversions is driven by our own business needs or the needs of a third-party stakeholder, in order to maintain the safety of our network.

For a chargeable diversion, we will be requested to undertake diversionary works to support the activities of third-party developers. For example, an external developer or customer may propose a new development or wish to carry out construction work near an existing gas pipe. Where this poses a risk to the safe and cost-effective operation of our assets, a diversion or protective works will be proposed and agreed with the relevant third party.

In some instances, it is not possible for us to charge the cost of diversion work back to a developer. This is explained further in chapter 3.

What insights shaped our thinking?

The importance of maintaining the security of supply was demonstrated by our engagement with consumers. Safety, including the prevention of emergency situations, was consistently highlighted as the most important or joint-most important priority across each engagement method during our phase 1 research, which included deliberative workshops, a domestic customer survey, a public survey, focus groups with hard-to-reach groups, stakeholder interviews and vulnerability interviews. The May 2019 Cadent employee survey found that ‘guaranteed gas supply’ was scored as the fourth-highest priority (with a weighted score of 4.49 out of 5) for staff when answering as ‘consumers’ (the survey asked staff to consider questions both as consumers and as employees).

Comparing uncertainty to costs included in our base plan

During RIIO-1, we received a fixed baseline allowance for diversions. For both chargeable and non-chargeable, our activity and associated spend at the beginning of the RIIO-1 period was relatively low.

Our RIIO-GD2 base plan included expenditure annually based on a volume equivalent to 80% of the minimum below 7 bar chargeable and non-chargeable diversions. This is associated with a total cost in our base plan of [Cost-sensitive

data] for chargeable diversions and [Cost-sensitive data] for non-chargeable. Further details are provided in Appendices 9.24 and 9.25 of the business plan.

Figure 4: ***Non-rechargeable diversions allowance (post-efficiency), £m 18/19 prices***

Our proposal for an uncertainty mechanism provided funding for volumes above and beyond those included in our base line plan shown in figure 4 above.

If we included all costs associated with diversions in the base plan as part of our RIIO-GD2 submission, we would have been required to develop a cost estimate based on our historical experience to date during RIIO-1. This would involve relying on trend analysis to inform future demand for diversions work, which represented challenges as the workload is customer driven. Furthermore, we would have been required to assume that the future workload mix would remain unchanged, and that work undertaken to date is representative of future diversion needs.

There was a credible risk to Cadent that we may underestimate future volumes of required work, or that more complex interventions may be required in RIIO-GD2 in response to the changing requirements of consumer s and developers. We would have faced an incentive to price risk into base plan estimates for reinforcements in order to ensure we were adequately funded if there was a significant growth in consumer demand for diversions.

However, this created a risk to consumers. Volumes might outturn below an allowance in RIIO-GD2, and this could have created an opportunity for windfall gains for Cadent.

Chapter 3.0
Accommodation of third party works

Chapter 3.1.1 – Scope, trigger and needs case.

We have an obligation under Regulation 13 of the Pipelines Safety Regulations 1996 (PSR) to ensure that our pipelines are maintained in an efficient state, in efficient working order and in good repair. Where third party encroachment (a structure is erected over or in close proximity to our asset) or infrastructure work occurs over or nearby our gas assets, we may need to divert or relocate them to minimise the risk of damage and to ensure that the assets can be safely operated and maintained in future. It also represents a material risk to the public with risks such as explosions and fire. Furthermore, when a structure infringes on a gas pipeline, it poses significant risks to its integrity, leading to potential safety hazards. The overlying structures can exert undue pressure and stress on the pipeline, increasing the likelihood of failure.

Diversions are typically chosen as a last resort when other more cost-effective solutions (for example, abandoning the main or relocating the offending structure) are not feasible.

There are a number of different types of diversions. The scope of the Re-Opener covers non chargeable work only, while costs from chargeable work are directly recovered from customers.

The following list sets out scenarios where we may need to undertake a non-chargeable diversion:

- We may need to undertake non chargeable diversions to resolve the encroachment where the legal position has been assessed and the prospects of success through the courts are low.
- Where structures constitute a substantial interference with our ability to carry out essential repair/maintenance work.
- Under the stipulations of [Sensitive Data] National Agreement, which serves as a licensing framework for all pipelines within [Sensitive Data] land, we are obligated to cover the costs associated with the installation, maintenance, or removal of these pipelines. Additionally, [Sensitive Data] reserves the right to compel Cadent to modify any sections of our pipelines in alignment with their urgent or scheduled projects, with all related expenses being Cadent's responsibility.

Each encroachment scenario is assessed in a considered way with our legal team. This will include a review of legal rights (easements, restrictive covenants etc) and an assessment of the chance of successfully pursuing an injunction to remove the encroachment and negotiations with the landowner. Even where chances of legal success are low, Cadent will always try to reach out to the landowner to achieve a pragmatic resolution. Where landowners are resistant, further legal assessment is carried out to review the prospects of success of legal action. in some cases, where the prospects of success are low. Cadent will consider other resolutions including carrying out a non-chargeable diversion.

Regardless of whether a legal challenge is viable or not, we must undertake this work to meet our obligations under the PSR and other health and safety legislation,

including the Health and Safety at Work Act 1974. If we do not carry out the required work, in addition to breaching our responsibilities under the Regulations, there is a risk that our pipelines and infrastructure will be damaged and that we are unable safely, quickly and cost-effectively operate and maintain our pipeline-assets, or secure supply in the event of an emergency.

Chapter 3.1.2 – *Items in Scope*

The scope of work for each intervention varies significantly for each individual case, but may cover elements such as:

- Diversion works
- Contributions by Cadent to the landowner to relocate or remove the structure
- Legal costs associated with structural removals

The diversion works include all investment to divert gas pipes and associated assets where costs cannot be recovered.

Chapter 3.1.3 – *Investment Driver*

The main driver for investment is the safety risk, risk to security of supply and risk to health and safety of the public. There is also risk to our ability to access and maintain assets in accordance with our statutory duties and obligations.

The construction of a building or structure directly over gas assets has the potential to adversely affect the integrity of the pipework and our ability to properly maintain it. It also represents a material risk to the public.

Encroachments represent a risk for the following reasons:

- **Gas entry into buildings**: The pipework that is located beneath buildings or structures provides a preferential route for gas ingress into the premises. Depending on the pipework interaction with the building, escaping gas may accumulate in voids leading to a potentially explosive atmosphere.

- **Occupier safety**: There is a risk that the change in environment where our assets are located will pose a risk to occupier safety

- **Pipework loading**: The pipework is at risk from loads applied by the new building or structure and is more susceptible to damage

- **Pipework access**: The installation of a building or structure above the pipe prevents Cadent from carrying out its obligations under the PSR ensure the pipe is accessible for maintenance and that it is maintained in an efficient state, efficient working order and in good repair.

Chapter 3.1.4 – *Overview of resolving Third party encroachments of mains*

There are generally three options when faced with the encroachment situation:

- Relocate the gas asset,
- Remove the offending building or structure from above the pipeline, or
- Abandon the pipeline

Removal of the offending building or structure can be achieved by either:

- Obtaining consumer acceptance and compliance
- Offering a consumer incentive to remove the structure
- Obtaining an injunction through legal proceedings, which forces the consumer to remove the relevant structure

In some instances, diversionary works will be undertaken as the most economic and efficient resolution. This will be strongly considered in the following instances:

- Where the integrity of the asset is compromised
- Where the asset is part of our mandatory pipeline Iron Mains Risk Reduction programme
- Where the value of the diversion works is less than the perceived cost (including resource cost) of structure or building removal

Chapter 3.1.5 - *Process*

1 - Identification

There are various ways that encroached mains or pipelines are identified, for example:

- Repair activity
- Mains replacement
- Plant protection visits
- Consumer Compliant
- Line walking
- Aerial surveys
- Vantage point surveys
- CP surveys
- MOB surveys
- Lands work
- REP/2 / MRPS surveys
- Desktop identification

2 - Operational Monitoring

When encroachments are identified, operational monitoring is carried out on potentially affected mains and pipelines. This monitoring is continued until it's confirmed that there is no encroachment, or until a resolution is implemented.

Operational monitoring is required to confirm the integrity and stability of the pipe that has been encroached and to ensure that no leakage is present. This is completed by undertaking a leakage survey using a specialist gas detection instrument.

Where access to the property has been obtained, surveys of the area in which the pipework is located are undertaken, paying particular attention to all possible ingress points, along with high and low-level checks. If leakage occurs, temporary mitigation measures are utilised until a permanent solution is found.

Operational monitoring in the form of leakage surveying is carried out at the below frequencies:

Material	Pressure	Maximum interval between checks
Steel / Reinforced Thermoplastic	HP	14* calendar days
Metallic	IP	14 calendar days
PE	IP	28 calendar days
Metallic/other	MP	14 calendar days
PE	MP	28 calendar days
Metallic/other	LP	14 calendar days
PE	LP	28 calendar days

Figure 5 – Operational monitoring cycles for encroachments

Additional mitigation measures may be employed on a case-by-case visit, these may include:

- Coating surveys
- Cathodic protection surveys
- Additional site monitoring
- Temporary disconnection & provision of alternative supplies
- Installation of gas detection equipment
- Increased ventilation
- Valve installation (dependent on downstream criticality and building risk)
- Development of an isolation plan

For steel pipelines additional checks in the form of coating defect checks may be performed to determine if the pipeline may have been damaged during construction and if further intervention required on the asset.

In scenarios where a main or pipeline is intermediate or high pressure a Quantitative Risk Assessment (QRA) will be conducted. The QRA is used to determine whether the existing location of the pipeline can be retained as it is, by

carrying out risk studies such as Process Hazard Analysis (PHA), Fire and Explosion Hazard Analysis (FEHA), Crater and Rupture Study.

3 - Confirmation Survey

All identified encroached mains and pipelines are passed from the encroached asset team to our operations team who confirm whether the pipework is encroached within 60 calendar days of issue.

Operations initially attempt to confirm if the main is encroached through non-intrusive methods if the pipework is able to be traced. If the non-intrusive methods return inconclusive results, then trial holes are undertaken to confirm whether the pipework runs beneath the building.

This section provides guidance on the methods that can be used within operations to gather the information to allow accurate update of the asset record. Industry guidance on underground utility location (PAS 128) identifies the following survey types:

- **Survey Type D** - Desktop search and online map services (DR4 process). Use of existing records and online maps for information. Can be used alone or with other techniques.
- **Survey Type C** - Visual surveys on-site with support from desktop searches and existing plans. Relies on visible on-site information like service entries, valves, scars, etc.
- **Survey Type B** - Location using detection devices, including:
    - Cat and Genny (C-Scope) survey
    - Camera and Sonde
    - Ground Penetrating Radar (GPR)
    - Other innovative technologies with approval (e.g., acoustic pipe tracers)
- **Survey Type A** - Observation of exposed underground apparatus in an excavation or chamber. Typically used in trial holes after other survey types. Record details, material, position, diameter, etc., and involve providing supporting photographs.
- **Combination of Techniques** – Use of multiple methods if needed. For example, excavation for Cat & Genny survey, camera technology, etc., to gather comprehensive information.

Where the site survey indicates that the structure is over or near a pipeline but is within the building proximity distance outlined in tables x and y below that shall be recorded as an encroachment.

Type of Main	Diameter of Main (mm)	Minimum Building Proximity Distance (metres)			
		LP ≤75mbar	MP >75mbar - ≤ 2 bar	IP > 2 bar - 5.5 bar	IP > 5.5 bar - ≤ 7 bar
*Non-Inserted	Up to 125	0.25	2	4	6
	126 to 355	1	2	4	6
	356 to 500	1	2	4	8
	501 to 1000	1	5	13	15
*Inserted	Up to 125	0.25	1	2	3
	126 to 500	0.5	1	2	3
	501 to 1000	0.5	1	3	3

Figure 6 – PE Mains Building Proximity Distance

Operating Pressure	Minimum Building Proximity Distance (metres)
LP	0.25
MP	1
IP	3

Figure 7 – Steel Mains Building Proximity Distance

4 – Resolution

Where the asset is confirmed as encroached, works will be required to either move the encroached main (as a diversion) or through negotiations/offering incentives to the customer to remove the structure, if these are unsuccessful an assessment on the chances of success of on an injunction is considered.

The Regional Land Officer will investigate the encroachment and establish the rights of Cadent to protect this asset before approaching any landowner to discuss resolution, with advice from the legal team where appropriate. This initial assessment is provided to the Investment Programme Manager to determine if:

- Any engineering (diversion/isolation) works are required.
- The works are to be undertaken on a chargeable or non-rechargeable basis.
- Legal action via an injunction is required to remove the encroachment.

The resolution mechanism considers the site-specific circumstances associated with the asset and level of risk posed, combined with the land and legal rights for the asset. This dictates the ability to recover the cost of the resolution. Support is sought from Engineering Services at the options appraisal stage as required. The options considered are outlined below.

Chapter 3.1.6 - *Options Considered*

Option 1 - Abandon the main
Option 2 - Removal of the offending structure
Option 3 - Diversion of an encroached main or pipeline

Option 4 - Do nothing Option

Option 1 – Abandon the main

Network analysis will be performed to evaluate whether consumers will maintain a resilient supply in the event the main is abandoned. Should the analysis confirm this continuity of service, opting for abandonment becomes the preferable choice. This approach is favoured due to its cost-effectiveness and minimal disruption to consumers, as it significantly reduces the need for extensive remedial works.

Option 2 – Removal of the offending structure

Negotiations are made with the landowner about removing their structure. If these are unsuccessful the legal remedy for an encroachment is an application to the court for a mandatory injunction to have the encroachment removed subject to an assessment of our chances of success. If there is a reasonable chance of success and costs of pursuing do not outweigh costs of resolving the issue through another route i.e. diversion, this option is pursued.

Depending on the building (size, construction, integration) and pipe detail (material, depth, etc.) it may not be appropriate or possible to remove the encroachment in a safe manner. The feasibility of any proposal to remove the encroachment is also reviewed (from a safety and engineering perspective).

Option 3 - Diversion of an encroached main or pipeline

In cases where diverting an encroached asset is the most economic and efficient solution, systems are in place to promptly issue the work to the delivery mechanism.

Where possible and where it is economic and efficient to do so, Cadent considers trying to recover diversion costs from the relevant property owner through damage claims.

Option 4 – Do nothing option

A "do nothing" option isn't viable because encroachments significantly risk the integrity of our assets and can prevent us from safely maintaining our network in accordance with our obligations under PSR and other health and safety legislation. If the pipe was to fail beneath the structure, it is almost certain that it would result in a gas in building event leading to evacuation of the property until the situation could be brought under control. Due to the encroachment on the pipeline, Cadent would not be able to effectively pinpoint the source of the escape and, in any event, would not be able to carry out an excavation in order to carry out a repair. As a result of not being able to carry out a repair Cadent would have to essentially manage the escape until the pipeline section could be re-laid around the overbuild. This is a complex engineering task often with lead in times for available equipment,

fittings, and resource, in any event the project would take a number of months to be carried out. Notwithstanding the obvious safety issues posed by this, there could potentially be gas escaping from our pipeline for a pro-longed period of time.

Furthermore, Regulation 13 of the Pipeline Safety Regulations mandates the maintenance of pipelines in an efficient, working order, and in good repair to ensure safety and prevent loss of containment. However, encroachments limit access for essential maintenance and inspection, a key requirement under this regulation. Routine examination and monitoring, vital for maintaining pipelines in a safe condition, become exceedingly difficult when structures encroach upon a main or pipeline. Such encroachments also hinder the implementation of comprehensive safety management systems, especially for major accident hazard pipelines, as access to crucial components like valves is restricted.

Chapter 3.2: Cost Information – Diversions

Chapter 3.1 outlined the risks, resolution strategies, and cost recovery methods associated with third-party encroachment on our assets. Subsequent sections are organised into distinct chapters for clarity. Chapter 3.2 provides cost information for diversions and structural removals, mainly focusing on cases involving residential or small commercial entities where the average cost is low. Actual costs incurred are provided, followed by an accompanying forecast methodology. The insights in Chapter 3.1 guide our approach to handling these 'smaller' encroachments, with costs being presented collectively (cohort). Conversely, for larger and more complex projects, we provide a bespoke narrative for each project, outlined in chapters 3.3 to 3.11. Furthermore, information regarding the encroachment of our service pipes is outlined in chapter 3.12.

Within this investment case there are two types of work:

- Relocation/Diversion of the gas asset or,
- Removal of the offending building or structure from above the pipe.

In this scenario, non-chargeable diversions aim to mitigate risks associated with gas assets located beneath or near buildings. The initial step is assessing the necessity of the existing asset, with a preference for abandoning the pipe if it ensures continued resilient gas supply to all consumers. If abandonment is not viable without disrupting gas supplies, rerouting the assets, or removing the offending structure becomes necessary.

Our proposal involves utilising costs and volumes from completed remediations (including diversions and structural removals) incurred after April 1, 2021, in the networks where they were implemented. Our forecast for the rest of the RIIO-GD2 period is based on encroachments identified but scheduled for future remediation within RIIO 2. For example, an encroachment identified in the first year of RIIO-GD2 may be planned for delivery in the third year. This approach will be referred to as a 'workstack'. This method provides a reasonable and representative foundation for forecasting at the program level. Furthermore, we have included a

provision for unforeseen encroachments we are currently not aware of and may identify in future beyond those located in our planned 'workstack'. We consider this to be a reasonable, representative, basis for the forecast.

There are a number of different options for using our approach as the basis for the forecast of non-chargeable diversions. We have split this workstack based on the two remediation types that are in scope, a diversion or structural removal/legal remediation.

The three options below are for **diversions**:

Option 1: The complete workload allocated in our workstack
Option 2: The average workload across years 1, 2 and 3 of RIIO-GD2
Option 3: A conservative view of workload allocated in our workstack

Option 1: The complete workload allocated in our workstack (preferred)

During the initial three years of the RIIO-GD2 period, we focused on conducting preliminary activities such as exploratory trial holes and design work to assess the scale of encroachments within our network accurately. Concurrently, we managed a heightened volume of mandatory Iron Mains Risk Reduction Programme projects. This increased workload meant that our supply chain had limited capacity to address encroachment diversions, a factor that likely would have led to higher costs had these projects been pursued more aggressively at the time. Furthermore, we needed to obtain the requisite easements and access rights to carry out the necessary diversions. With these rights secured, we were able to plan and allocate the work for delivery. Consequently, this strategic approach has led to a noticeable increase in the volume of remediation activities scheduled for the final phase of the price control period, markedly more than what was completed in the initial stages.

Option 2: The average workload across years 1, 2 and 3 of RIIO-GD2 (discounted)

In Option 1, we outlined our initial approach during the onset of the price control period, focusing primarily on organising our workstack and gaining a comprehensive understanding of the encroachment volumes in our network. This preparatory phase was crucial, but it resulted in fewer resolutions of encroachments compared to what we plan to resolve in the upcoming years of the price control period. Consequently, relying on the average volumes of remediations completed in the first two years does not offer a reliable estimate for future projections. This discrepancy in volume between the initial years and the subsequent period led us to discount this approach as a viable forecasting option. Our decision is based on the rationale that the early years were more about groundwork and planning, which naturally entailed lower completion volumes, whereas the remaining period will be more execution-focused, leading to higher volumes of encroachment resolutions.

Option 3: A conservative view of the workload allocated in our workstack (discounted)

In our RIIO-GD2 submission, specifically within Appendix 9.24 of our business plan under section 7.4 Option 4 (our preferred option for non-rechargeable diversions), we adopted an approach characterised as a "conservative view based on minimum workload." This method entailed forecasting RIIO-GD2 volumes, and costs based on 80% of the minimum length of diversion completed during the RIIO-1 period. However, this approach is not suitable for this Re-opener. Our current submission differs significantly as we already possess clear visibility of the expected workload. Consequently, applying a percentage reduction or a 'minimum workload' expectation is not justifiable in this context. We have already identified a specific set of volumes for delivery, and in many instances, these are in the process of being tendered. Therefore, the logic underpinning this previous approach does not align with our current circumstances, leading us to discount it as a viable option for this submission. Our focus now shifts towards a more accurate and direct estimation based on known and planned work, reflecting a more proactive and precise approach to forecasting for the RIIO-GD2 period.

Chapter 3.2.1 – Preferred Option

We've initiated a tendering process to allocate work packages through our supply chain. Our cost evidence approach incorporates any diversions completed in the first three years and includes a detailed forecast for the remaining price control period.

This method represents the most economic, efficient, and effective strategy. It allows us to leverage our enhanced understanding of our network's encroachments and efficiently allocate resources. This approach ensures and provides a more accurate forecast of the volumes we aim to remediate throughout the RIIO-GD2 period as the work is allocated for delivery.

	2021/22	2022/23	2023/24	2024/25	2025/26	Total
EN						
NL						
NW						
WM						
Total						

Figure 8: ***Volumes for Option 1 – found in the "Encroached Mains Volumes tab" in Appendix 1 – Diversions Re-Opener Finance Tracker***

Figure 9*: Total cost for Option 1 Can be found in the "Total Encroached Mains Cost" Tab in Appendix 1 – Diversions Re-Opener Finance Tracker*

Figure 9 presents the historical data on remediated diversions from the first three years, alongside projections for years 3 to 5, based on our planned remediation workstack.

In figure 9 we detail the total costs, calculated using the following methodologies:

- **Actual Costs**: When actual costs are incurred, they are directly reflected in our table.
- **Target Costs/C4 Estimates**: In the absence of actual costs, we utilise figures from our target cost/C4 estimates. C4 estimates are comprehensive and detailed, encompassing several critical components: final design elements, specific engineering requirements, project-specific assumptions and risks, materials utilised, detailed working drawings, and a clearly outlined project program. These estimates play a pivotal role in identifying and planning utility mitigation measures. Notably, since April 1st, 2021, these C4 estimates have been integrated into our Guaranteed Standards of Performance, ensuring high accuracy and reliability in our cost forecasting and project planning processes.
- **Average Costs**: For encroachments identified but currently undergoing design, we have used an average of actual costs incurred which is [Cost-sensitive data] based on historical remediation.

We meticulously catalogued every identified encroachment in the '**Encroached Mains Workstack'** worksheet of our finance tracker, detailed in **Appendix 1 – Diversions Re-Opener Finance Tracker**. This comprehensive list includes the current status of each encroachment and specifies the method used to calculate its unit cost.

Demonstration of Efficiency

- Where multiple encroachments are identified in one area, steps are taken to deliver them as part of one scheme reducing disruption to the landowner and utilising economies of scale.
- All Diversions works are competitively tendered as part of our Dynamic Procurement System (DPS). Local delivery partners competitively tender for a scheme and their bids are evaluated and scored based on our DPS

framework. The works are awarded to the highest scoring partner/contractor.

Chapter 3.2.2: Cost Information – structural removal/legal remediation

In our [Security Data] network, we have incurred some costs associated with legal fees for various encroachments and a structural removal. This can be found in "**[Security Data] land costs**" in **Appendix 1 – Diversions Re-Opener Finance Tracker.**

Figure 10 – "[Security Data] Lands Costs Tab" in Appendix 1 – Diversions Re-Opener Finance Tracker

We will now explore the selected cost forecast options for structural removals and legal remediation for ongoing remediation that haven't been completed. This approach involves physically removing structures or pursuing legal resolutions when these are deemed more efficient than pipeline diversion. Typically, these remediation efforts are associated with our High/Intermediate pressure pipelines, where the cost implications of diversion are significantly high due to challenges around design, route availability etc. Consequently, opting for structural removal or legal remediation can be the most pragmatic, cost-effective, and efficient choice. The options are as follows:

Option 1: The average workload across years 1, 2 and 3 of RIIO-GD2
Option 2: High Level Assumptions
Option 3: Additional Window - Uncertainty mechanism proposal at RIIO-GD2
Close out

Option 1: The average workload across years 1, 2 and 3 of RIIO-GD2 (discounted)

This approach would see us use costs and volumes associated with completed structural removals/legal remediations at the start of RIIO-GD2.

The multifaceted nature of each structural removal or legal remediation case makes it exceedingly challenging to apply historical remediation data for accurate forecasting of costs and volumes for the remainder of RIIO-GD2.

Each remediation case is distinct, with its unique set of challenges that defy standardisation or a unit cost approach.

There is a tangible risk for Cadent in potentially underestimating the future costs of the required work. This uncertainty could result in]us incorporating a risk margin

in the cost estimates provided in the Re-Opener, especially if preparing for a worst-case cost scenario in relation to structural removals.

Given these uncertainties we have discounted this option.

Option 2: High Level Assumptions (discounted)

This approach uses our informed assumptions to estimate the property's value impacted by the remediation. These cases are subject to ongoing valuations and legal processes, so we cannot provide a precise cost estimate. Our proposed estimation method offers a ballpark figure, which, while not exact, gives a rough idea of potential costs.

Address	Description	Cost Estimate

Figure 11: Cost estimate for Structural removal/land remediation

Implementing this approach would necessitate assigning a 'best case' and 'worst case' scenario to each individual encroachment case, thereby shaping our cost estimates. In this framework, a 'best case scenario' would correspond to the lower end of our cost range, as indicated in the preceding table, while a 'worst case scenario' would be associated with the upper end of the range. However, we have identified two major concerns with this method. Firstly, we are not confident that this approach would provide an accurate means of estimating costs, leading us to discount it. Additionally, the unique and significantly varying nature of each encroachment case makes it exceedingly challenging to uniformly apply a scenario analysis across all cases. For a comprehensive overview of all ongoing cases, refer to **Appendix 2 – Awaiting Land Remediation** which lists all cases across each network. Figure 11 in this document is a snapshot of the information available in this worksheet.

Option 3: Additional Window - Uncertainty mechanism proposal at RIIO-GD2 Close out (preferred)

We have a good understanding of pipeline diversion costs, particularly below 7 bar; this cost and volume is reflected in option 1 of chapter 3.2. However, the cost projections become notably less certain when it comes to remediations that necessitate structural removals or legal interventions, which will depend heavily on the unique characteristics of each site, which adds significant complexity to accurately forecasting the total program cost.

This complexity is further amplified by the challenges associated with land access and the varying legal costs that may arise in different contexts. For a clearer understanding, figure 12 has been compiled to highlight the key factors that contribute to this uncertainty in cost forecasting. These factors underscore the

variability and site-specific nature of these remediations, reflecting the intricate and often unpredictable nature of such interventions.

Factor	Explanation
Type of Structure	The nature of the structure (e.g., sheds, houses, commercial buildings) affects remediation complexity. Each type has different removal costs and legal considerations.
Customer Type	The willingness of a customer to comply (e.g., domestic customers may be less willing to remove their homes) varies and impacts the feasibility and cost of legal actions.
Property Valuation	Agreeing on a property's valuation for compensation purposes is complex, as it requires negotiations and possibly independent appraisals.
Legal Complexity	The legal process for obtaining an injunction can vary in complexity based on factors like the presence of restrictive covenants or the clarity of property rights.
Duration of Legal Proceedings	The time taken for legal proceedings to conclude can vary greatly, impacting cost forecasts due to prolonged engagements with legal counsel and potential court delays.

Figure 12: Forecasting Factors

Each case presents unique challenges, making standardisation of forecasts impractical.

Property valuation is another critical factor. Determining a fair market value for compensation involves negotiations and can require independent appraisals, adding layers of complexity and unpredictability to the costs. The legal route, while necessary in some cases, is seldom straightforward. The presence or absence of restrictive covenants, the clarity of property rights, and the feasibility of enforcing an injunction vary widely, impacting both the duration and cost of legal proceedings.

There is a credible risk to Cadent that we may underestimate future costs of required work.

We would face an incentive to price risk into our Re-Opener cost estimates to ensure we were adequately funded if we anticipate a worst-case scenario for costs relating to structural removals.

Given the uncertainty on the costs and to a lesser degree volume of land resolutions that will be required in RIIO-GD2, we have evaluated the appropriateness of different mechanisms that could address this risk:

Mechanism Option	Description

Volume driver (discounted)	A volume driver is not wholly appropriate for this risk. Whilst we are confident in the volumes of land resolutions, future costs will be specific to the nature of individual cases we are required to undertake. It would be inappropriate to develop unit costs across the full range of potential interventions, which would require an assumption that won't wholly be based on fact due to the uncertain nature of land/legal resolutions and final costs discounting for a worst-case scenario.
Additional Re-opener Window (preferred)	An additional Diversions Re-Opener window under the existing Special Condition 3.20 Diversions and Loss of Development Claims Re-Opener policy and subject to the existing materiality threshold. This accounts for uncertainty in costs when the requirements for projects/cases in RIIO-GD2 are unknown. In this scenario, it relates to the legal challenges associated with land resolutions. Elements of this are well suited to this mechanism, as the specification of works we will be required to undertake is currently unknown. This mechanism, if it were to be permitted at close out of RIIO-GD2 would allow us to develop an evidence-based cost approach at the end of the RIIO-GD2 period once the scope of legal review is clearly outlined with accompanying cost evidence, which would be subject to review from Ofgem.
Use it or lose it allowance (PCD) (discounted)	This would involve a price control deliverable (PCD). While this would protect consumers from under-delivery, a PCD does not address the challenge we face in forecasting a total cost when the volume and unit costs of a land resolution are unknown. There is also a risk that barriers are created if there are insufficient funds to deliver against any new requirements.

Figure 13: ***Uncertainty mechanism options***

We have also undertaken a qualitative assessment of uncertainty in this area to further understand the need for an uncertainty mechanism for diversions.

Chapter 3.2.3 – Preferred Option

Option 3 is our preferred option as it provides us the best opportunity to recover costs relating to land/legal remediation by addressing the difficulty we face in forecasting costs and from providing inaccurate cost estimates. We are proposing to address uncertainty related to costs of legal/structural removal resolutions to encroachments using an additional **Re-Opener window** at close out of RIIO-GD2.

In this submission, we would propose the costs we intend to recover relating solely to costs of structural removals/legal resolutions of encroachments, providing

evidence on why they are appropriate and efficient. This mechanism ensures that scrutiny remains over any future costs we intend to reclaim.

Operation of the proposed Re-Opener in practice:

- Claiming costs through the Re-Opener: As outlined above, we proposed that costs be reclaimed during close out of RIIO-GD2. We believe this is a point in time whereby evidence can be presented in full. As part of this process, we would demonstrate costs incurred relating to land resolutions of encroachments.

Evaluating our proposed uncertainty mechanism

A Re-opener in this context provides an opportunity to provide accurate cost information with regards to land resolutions of encroachments. As outlined above, there are risks associated with including a cost estimate in our base Diversions Re-Opener plan at present, creating opportunities for Cadent to make losses or windfall gains, specifically around more complex activities.

Nevertheless, it is important to fully evaluate the behaviours that our proposed uncertainty mechanism (re-opener) will encourage, to ensure it does not create perverse incentives. Below, we consider positive behaviours that a mechanism should promote.

Behaviours and incentives	Evaluation
To minimise costs	The costs we submit to Ofgem through the re-opener process will be subject to review and challenge. Any costs identified as inefficient will be disallowed. This creates an incentive to focus on incurring efficient costs and demonstrating this with robust evidence.
To deliver required work	Ofgem will also focus on ensuring that these only relate to relevant activities, in this scenario costs associated with land and legal remediation of encroachments. Any costs submitted for work Ofgem do not believe to be required will be disallowed, creating an incentive to focus on work with a compelling need. There may be concerns that the re-opener does not maintain an incentive to undertake required work. However, as mentioned above, this work is currently ongoing or in early stages of legal proceedings and there is no scenario where we don't undertake the required work which needs to be addressed to maintain safety and our obligations under the Gas Pipeline Safety Regulations. Failing to do so would create safety risks for consumers as well as financial and reputation risks to our business.
Consumer Protection	As costs will be subject to scrutiny from Ofgem, it ensures we only provide costs incurred for legal/structural removals of

	encroachments as opposed to providing over inflated estimates of difficult to predict scenarios protecting consumers from fluctuations in their bills.

Figure 14: Evaluating incentives created by our proposed uncertainty mechanism

Re-openers represent an optimal mechanism for recovering costs associated with legal/structural removal remediations, particularly within the framework of RIIO 2. They offer an opportunity to present actual incurred costs at the close of the regulatory period, ensuring that the expenses related to these complex legal proceedings are accurately accounted for. Additionally, the Re-Opener mechanism inherently incentivises efficiency. As actual costs are scrutinised by Ofgem, there's a clear incentive to manage legal proceedings as cost-effectively as possible. This efficiency drive not only aligns with regulatory expectations but also safeguards consumers interests, ensuring that the financial implications are managed judiciously. Thus, Re-Openers strike a balance between providing a means to recover whole costs and encouraging a disciplined, economical approach to legal remediation processes.

Chapters 3.3 to 3.11 offer further details of more complex diversion projects, providing project-specific details such as the justification, the various options evaluated, and their associated costs. This detailed approach is particularly necessary for these intricate projects, where a cohort-style presentation would not adequately capture the nuances and specificities involved.

Chapter 3.3 - Project 1: [Security Data]

Chapter 3.3.1 - Needs Case and Problem Statement

This project delivered a diversion of a 24-inch steel LP main on [Security Data]. The main runs under a commercial property and was identified following a number of leakage events where gas in building was present. The main was showing continued signs of degradation with escapes occurring on multiple occasions.

Figure 15 – Encroachments on [Security Data]

The images provided in figure 15 illustrate the structural encroachment of our main. Photo 1 captures the main as it traverses a bridge over railway tracks, leading directly towards a building. Photo 2 offers a view of the said building, which is imposing upon the main's designated pathway. Lastly, Photo 3 reveals the interior perspective, where the main can be seen within the confines of the building itself. This sequence of photos effectively documents the progression of the main from a public thoroughfare into a private enclosure, highlighting the intrusion of the building onto the main's established route.

Investment Drivers

The fundamental reason for considering this investment is to uphold the safety and integrity of our main as per our licence obligations. The live gas main running beneath the building presented a significant hazard and intolerable risk; if left unaddressed, it could lead to further gas leaks, endangering the safety of the building occupier and passers-by amplified by specific location factors e.g. proximity to rail; high traffic etc. Additionally, the main is under threat from the stress of pipework loading.

In summary the investment Drivers are:

- **Preventing a Gas Emergency**: A breach in the main could have prompted a critical emergency, necessitating the closure of [Security Data], a vital main road. The consequent emergency measures and road shutdown would disrupt traffic and lead to increased costs and inefficiencies.
- **Public Safety**: The potential of a gas leak raises the risk of fires or explosions, presenting a clear danger to the public's well-being.
- **Legal Compliance**: Our operations are bound by stringent legislative and regulatory frameworks, which include:
    - Adhering to the Pipeline Safety Regulations, with a specific focus on Regulation 13, mandating the maintenance of pipelines to ensure they remain in good repair.
    - Following the Health and Safety at Work Act, which sets out our duties to secure the health and safety of workers and the public.

Chapter 3.3.2 – Options Considered:

We reviewed options for resolving the encroachment but did not have the legal right to remove the structure, resulting in a diversion being the only viable option as it could not be abandoned. The presence of an ongoing leak that was being managed led to an urgent meeting being held with key stakeholders to review available options which considered safety as well as impact on the community from ongoing disruption due to the location of the encroachment being on a busy road. The local authority was keen to pursue a permanent solution given previous leakage history and the impact to residents from resulting repair activities. Thus,

we collaborated with the authority and our supply chain to mobilise and complete the diversion with the required road space being provided.

Options Analysis Methodology

The following options were considered for [Security Data]:

- **Option 1**: Do Nothing – leave encroached main in its current state and continue to monitor
- **Option 2**: Diversion of main and removal of crossing
- **Option 3**: Diversion of the main and leave abandoned crossing in situ
- **Option 4**: Removal of the structure that is encroaching on our main
- **Option 5**: Abandonment

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3)** and the options considered in chapter 3.1.6.

	#1 Do Nothing	#2 Diversion of the main and removal of the crossing	#3 Diversion of the main	#4 Removal of the structure	#5 Decommission the main
Delivers business outcomes	Inadequate	Yes	Yes	Yes	Yes
Removal of Safety Risk	Inadequate	Yes	Yes	Yes	Yes
Effort to Implement	Minimal	Maximal	Average	Maximal	Average
Cost to implement	Not obtained	[Cost-sensitive data]	[Cost-sensitive data]	Not obtained as option was no feasible	Not obtained as option was not feasible
Legal Compliance	Not Compliant	Compliant	Compliant	Compliant	Compliant

Figure 16 – [Security Data] options analysis

Option 1: Do Nothing - Discounted

Leaving the main in its current position while monitoring it wasn't a viable option. We have a legal duty to eliminate intolerable risk to our main, and in this case, the building encroaching on the gas main was a clear hazard. Moreover, the repeated

and ongoing gas leak was a serious concern in itself, demanding an urgent resolution. Therefore, the option to 'do nothing' was ruled out. We had to act to find a solution to address the safety risks.

Option 2: Diversion of the main and removal of crossing - Discounted

The initial preferred option was to divert the main and remove the crossing (i.e. the main running alongside the bridge over the railway track as shown in Photo 1 of Figure 15). Removal of the crossing would involve significant negotiation with [Sensitive Data] and the local authority for access; lengthy planning in determining a safe method of work given the location and engineering complexity as well as more disruption to residents, businesses and people travelling.

The pressing safety issues caused by the encroachment meant that this was the immediate problem we needed to resolve. A considered decision was taken to prioritise resolution of the encroachment and resolve removal of the abandoned crossing pipe later when more feasible and design options had been considered.

So, it was determined the best course of action was to divert the main away from the encroaching building and remove the need for keeping live gas in the pipe crossing. This would leave the abandoned pipe crossing to be removed at a later date where due consideration could be given to potential options, negotiations with impacted stakeholders etc.

Option 3: Diversion of the encroached element – Preferred

We developed a diversion design to address the encroachment. This involved creating a new path for the gas flow by connecting two existing pipelines: a 24-inch diameter cast iron (CI) main and an adjacent 12-inch CI low pressure (LP) main. These connections were established on both sides of the railway bridge, strategically positioned away from the encroachment area.

The process included specialised flow-stopping and valve operations. This approach enabled us to temporarily halt the gas flow and safely cut and cap the encroached 24-inch LP main. By doing this, we effectively decommissioned the affected section, including the part that extended over the railway bridge.

The project involved abandoning 52 meters of the 24-inch steel main, 1.5 meters of the 24-inch cast iron, and 4 meters of the 12-inch CI main. We planned to lay 21.5 meters of new 355mm polyethylene (PE) main to replace the decommissioned sections using open-cut methods. This new installation also included two valves to serve as isolation points and the relocation of one service connection to align with the new pipeline configuration. Figure 17 shows evidence of the encroached main being abandoned and diverted.

Figure 17 – Evidence of risk removal

Option 4: Removal of the structure – Discounted

Our initial narrative in Chapter 3.1 emphasised our preference for always finding efficient resolutions to the issue of encroachments. Typically, one of our first approaches is to try and remove the obstructing structure, as diverting a main is not always the most practical / feasible option. However, removing the structure was not feasible in the case of the encroachment near [Security Data] due to several factors.

Firstly, the main in question was already leaking, and temporary mitigation measures were proving ineffective. This urgency meant we needed to act swiftly to manage the risk. The time required to remove a structure legally and physically in such a busy area would have been considerable. The potential for legal disputes, the logistics and feasibility of removal, and the accompanying costs, would have prolonged the situation. During this extended period, the risk of the main continuing to deteriorate would be high including unacceptable disruption to local stakeholders from repeated repair activity. There would also be no guarantee of a successful agreement to remove the structure and we may be exposed to significant cost demands given the location.

Therefore, diverting the main was the most viable and practical solution. It allowed us to quickly address the encroachment issue, minimising the danger posed by the leaking main and reducing the potential for prolonged disruption and escalating costs.

Option 5: Abandonment– Discounted

Network analysis was conducted to evaluate the impact of the proposed work on the 24” main, focusing on its implications for network security and service continuity for connected domestic, commercial, and industrial consumers. The

study revealed that decommissioning the 24” main under current demand levels would critically undermine network security, leading to an unacceptable drop in pressure affecting over 7,000 domestic connections, 45 commercial properties, and 5 industrial users, particularly to the north and south of the work site. Furthermore, network analysis showed pressure readings plummet from over 33mbar to a low of 2mbar, well below the acceptable threshold of 23.5mbar. This reinforced the need for a diversion to maintain uninterrupted supply and ensure network integrity for all users.

Chapter 3.3.3 – Preferred option

Preferred Option Rationale and Consumer benefit

The project minimised community disruption by employing specialised, low-impact techniques such as flow-stopping and open-cut methods for laying the main. This strategy, combined with the significantly reduced risk of gas leaks, provision of a more stable gas supply, and removal of encroachment risk, benefited consumers. The decision to opt for this approach was driven by the dual objectives of swiftly mitigating risk and minimising disruption. It represented a balanced blend of technical precision and a deep commitment to consumer welfare, effectively minimising inconvenience. This proactive and consumer-centric approach to resolving the encroachment issue showcased our commitment to prioritising consumer needs while efficiently addressing technical challenges.

Chapter 3.3.4 – Stakeholder Impacts

Once the feasibility of diverting the gas main was established, we promptly engaged with highway authorities. Recognising the urgency of the situation, they concurred that the project should proceed as soon as practically possible. This agreement supported the decision to focus solely on the diversion. As mentioned in option 2, removing the abandoned pipe crossing in this project would have necessitated additional inspections and full possessions in collaboration with [Sensitive Data], complicating and prolonging the process as well as adding significant cost.

Prioritising the diversion was crucial in maintaining our positive relationship with the Highway Authority. Any delay in addressing the issue, resulting in repeated leakage events or the need to revisit the site later to handle the encroachment, would have damaged this relationship and caused further disruptions on a significant transport route. We ensured that the impact on this vital road was minimised by taking prompt and decisive action, whilst protecting value to our consumer s overall.

Furthermore, we proactively engaged with local businesses that could be affected by our work. We aimed to keep access routes open as much as possible, mitigating any negative impact on their operations.

Chapter 3.3.5 Cost information

As this is a retrospective application and Cadent has completed the work, the costs borne by Cadent as reflected in "[Security Data] **Costs**" tab in **Appendix 1– Diversions Re-Opener Finance Tracker are** actual costs incurred**.**

Figure 18 – [Security Data]: Costs (18/19 prices)

Chapter 3.4 – [Security Data]

Chapter 3.4.1 - Needs Case and Problem Statement

Cadent detected a leak in their intermediate pressure (IP) mains pipeline on [Security Data], as highlighted in Figure 19. This leakage was attributed to corrosion, thought to be induced by DC stray current interference from another operator's cathodic protection (CP) system.

Figure 19 – Encroachment location on [Security Data]

The issue first came to light following public reports of a gas smell. Emergency repairs were swiftly conducted outside of regular working hours. These repairs included the removal and sealing of two leaking pressure points, the extraction of a leaking dust trap followed by the installation of a blank flange, and the application of two repair clips, along with valve greasing. Figure 20 illustrates the extent of the

emergency repair work. Further details on these temporary mitigation measures can be found in **Appendix 4 – [Security Data] Repair Evidence**.

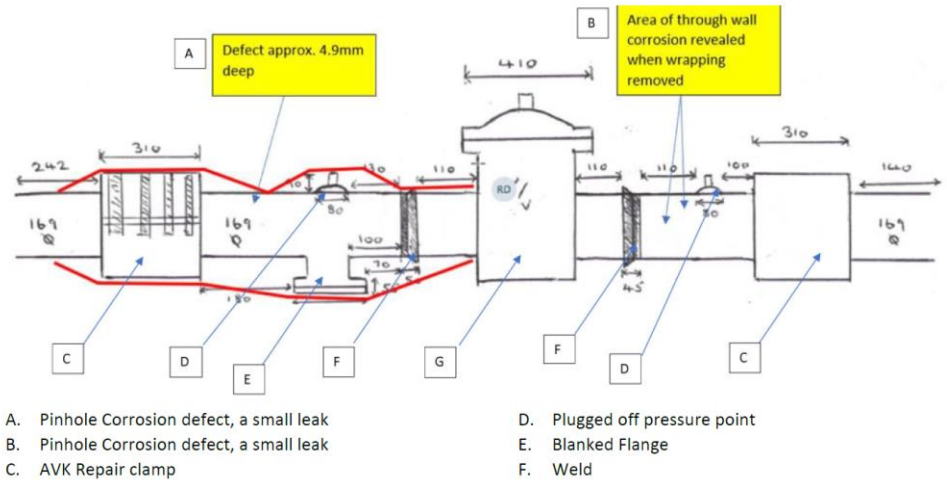

Figure 20 – Evidence of damage to the pipeline

During the preparation phase for a permanent repair solution, such as encapsulation, two additional leakage points were discovered. These were suspected to be minor pinhole leaks, but their location in the proposed encapsulation' landing area' posed a significant challenge, rendering smaller, individual encapsulations unfeasible.

The pipeline's unique geometry further complicated repair efforts. It was impossible to employ repair clips due to this geometry. A full encapsulation of the affected section was considered, potentially spanning 2-3 metres. However, given the significant weight of such an encapsulation and the extensive civil works required to support it, this option was discounted.

Alternative methods, such as composite wrapping, were also explored but eventually ruled out. Our contractor [Third Party Data] advised against it due to the pipeline's corrosion and unsuitable geometry for such a wrap. The affected section of the main was approximately 3 metres.

Consequently, the proposed solution was to implement [Sensitive Data] (an innovative repair technique) under a temporary pressure reduction to stop the leakage. A permanent fix to prevent future leaks in this area proved unfeasible. Further detail can be found in **Appendix 6 – [Security Data] assessment.**

The pipeline's extensive damage due to corrosion negated the possibility of cutting and capping the affected section. Thus, a permanent solution was needed to mitigate the risks to the compromised length, ensuring the continued safety and reliability of the gas supply in this area.

Investment Driver

The investment in addressing the leakage on the intermediate pressure mains pipeline on [Security Data] is driven by a critical need to ensure public safety and maintain the integrity of the gas supply. The leak caused by corrosion attributed to DC stray current interference presented significant risks. While effective in the short term, the initial emergency repairs uncovered further complications, necessitating a more robust and permanent solution, which is a diversion. The primary purpose of this investment was to secure the pipeline against current and future risks, ensuring the safety and reliability of the gas supply to the area.

In summary the key investment drivers are:

- **Public Safety**: Immediate action was required to eliminate any potential hazards posed by the gas leaks to the residents and businesses in the area.
- **Infrastructure Integrity**: The pipeline's integrity had been compromised due to corrosion
- **Technical Challenges**: The unique geometry and condition of the pipeline limit the effectiveness of standard repair methods, such as repair clips and composite wrapping.
- **Long-Term Solution**: Temporary fixes proved to be inadequate for the scale and nature of the problem, highlighting the need for a more sustainable, long-term repair strategy.
- **Operational Efficiency**: A permanent solution will prevent recurrent expenditure on temporary repairs and reduce the risk of future disruptions to the gas supply.

Chapter 3.4.2 – Options considered:

Upon detecting the leakage in the [Security Data] gas main, we promptly launched an extensive review of possible solutions, simultaneously implementing temporary mitigation measures. This approach was dictated by the complexities of the pipeline's location, the urgent need to address the leakage, and the broader challenges outlined in our investment case.

A meeting with key internal stakeholders was essential for a comprehensive evaluation of options. Our deliberations considered several critical factors: the urgency of the leak, the imperative of public safety, the necessity to maintain the integrity of our infrastructure, and the potential impact on the local community, especially considering the pipeline's proximity to residential areas and its placement along a busy A road.

Our response was shaped by a commitment to swift, safe, and community-conscious solutions, ensuring our gas supply infrastructure's continued reliability and safety while minimally impacting the surrounding area.

Options Analysis Methodology

At a high level the following options have been considered for [Security Data]:

- **Option 1**: Do Nothing
- **Option 2**: Diversion in another location
- **Option 3**: Diverting around the removed section
- **Option 4**: Abandonment

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#1 Do Nothing	#2 Diversion in other location	#3 Diverting around the removed section	#4 Abandonment
Delivers business outcomes	Inadequate	Yes	Yes	No
Removal of safety risk	Inadequate	Yes	Yes	Yes
Effort to implement	Minimal	Maximal	Average	Minimal
Cost to implement	Not Obtained	Not obtained as was not a suitable option	[Cost-sensitive data]	Not obtained
Legal compliance	Not relevant	Not relevant	Not relevant	Not relevant

Figure 21 – [Security Data] options analysis

Option 1: Do nothing – Discounted

The temporary mitigation measures in place needed to be revised to assure the long-term safety and functionality of the pipeline if it were to have remained in situ. It became clear that a permanent solution was necessary, and with permanent mitigation measures being unsuitable, the "do nothing" approach was not a viable option. The persistent risk of leaving the pipeline in its compromised condition required a more proactive and definitive solution. Therefore, the do nothing/minimum option was not considered further.

Option 2: Diversion in another location – Discounted

Given the location of the failure and the spatial constraints involved, our options for using different diversion routes were notably limited, particularly without causing substantial disruption. The pipeline's proximity to a property at the corner of [Security Data] further restricted our options, confining the diversion to the identified location.

Option 3: Diverting around the removed section – Preferred

This option considered diverting around the damaged section of the pipeline. For a detailed understanding of the design and all associated specifications related to this diversion. Please refer to **Appendix 5 – [Security Data] Detailed Design**

A new 150 Nominal Bore (NB) Carbon Steel (CS) pipeline extension around the affected damaged main is comprehensively outlined Figure 22 below. This 150 NB pipeline was installed using an open cut method and connected to the pre-established hot tapped locations, utilising welded tees 150NB x 150NB under pressure tapping (UPT). Detailed specifications for these connections can be found on page 35 of the design document.

Figure 22 – Diversion and cut out

Option 4: Abandonment – Discounted

The network analysis conducted for [Security Data] was based on a five-year demand projection applied to the network model. This forecast accounted for all

known residential, commercial, and industrial developments in the area, considering both the intermediate pressure network and all downstream demand.

Since the pipeline in question was an intermediate pressure (IP) main, abandoning it was not feasible. Such a course of action would have led to significant disruption and loss of supply to consumers in the surrounding area.

Chapter 3.4.3 – Preferred Option

Preferred Option Rationale and Benefit

The preferred solution in this unique scenario was to create a diversion around the damaged section of the main. This approach was strategically advantageous for several reasons. It was illustrated as the most cost-effective option in our analysis, effectively minimising financial impact. Moreover, this solution directly addressed and eliminated the safety risks associated with the damaged pipeline. Importantly, it also aligned with our business objectives to ensure an uninterrupted gas supply to our consumers. By choosing this diversion option, we effectively balanced cost-effectiveness, safety, and operational continuity, delivering a comprehensive resolution that catered to all critical aspects of the situation.

The primary benefit of this approach lies in the streamlined route of the diversion and the removal of the affected corroded section. The underlying rationale for this decision was the inability to perform a permanent repair on the corroded section due to its condition. Consequently, diverting around this section emerged as the only viable option. The chosen route addresses the immediate issue effectively and ensures a more reliable and sustainable solution for the future.

Chapter 3.4.4 – Stakeholder Engagement

Stakeholder engagement was deemed unnecessary in this scenario, as there were no significant stakeholders impacted by the selection of the preferred option. This option entailed a brief diversion on a main road, without involving complex issues related to land ownership or similar concerns, given its location on a public road.

Chapter 3.4.5 – Cost Information

As this is a retrospective application and Cadent has completed the work, the costs borne by Cadent as reflected in "**[Security Data] Costs**" tab in **Appendix1– Diversions Re-Opener Finance Tracker** are actual costs incurred**.**

Figure 23 – [Security Data] Costs (18/19 prices)

Chapter 3.5 – [Security Data]

Chapter 3.5.1 - Problem Statement and Needs Case

[Third Party and [Third Party] are undertaking bridge demolition and electrification works along their railway line near [Security Data], as depicted in Figure 26. A crucial element of this project involves a MP above-ground pipeline running adjacent to the bridge, circled in figures 24 and 25. [Third Party] contractors identified this pipeline. Additionally, [Third Party] requested Cadent to remove the smoke plates affixed to the pipeline, as they fall within the Overhead Contact Line Zone (OCLZ). In addition, bonding of the gas pipe was required, this would involve the decommissioning of the gas pipe to facilitate the work.

Figure 24 – [Security Data] overhead crossing and main

Figure 25 - Overhead Crossing close up

This above-ground pipeline was classified as HI5, indicating a significant fault requiring immediate intervention in the next annual maintenance cycle.

Furthermore, along the same stretch of main (blue line in figure 24) multiple encroachments consisting of domestic structures (sheds, annexes etc) had been identified shown in figure 26 below.

Figure 26 – encroachments on the main

Investment Driver

In summary, the key investment drivers are:

- **Public Safety**: As multiple encroachments were identified. The risks associated of gas in building, occupier safety and access issues arise, presenting a clear danger to the public's well-being.
- **Legal Compliance**: Adherence to legal and regulatory standards is a cornerstone of this investment. The project aligns with the Pipeline Safety Regulations, especially Regulation 13, which mandates the maintenance of pipelines in good repair. Removing the encroachment risk is a direct response to these regulations, ensuring legal compliance and safety.
- **Efficient long-term solution:** By diverting the main into the new bridge deck, the project eliminates the ongoing risks and maintenance costs associated with an above-ground crossing over an electrified railway. It also solves the current encroachment issue offering a long-term, cost-effective solution. It reduces the need for future maintenance and remediation works, which are typically costly and complex due to the challenges of accessing [Third Party] tracks.

Chapter 3.5.2 – Options Considered

Options Analysis Methodology

At a high level the options considered include:

- **Option 1:** Do Nothing – discounted
- **Option 2:** Keep the above ground crossing and carry out maintenance as this scored as HI5 – discounted
- **Option 3:** Abandon the asset entirely - discounted
- **Option 4:** Diverting the asset into the bridge deck – preferred

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#1 Do Nothing	#2 Keep the above ground crossing	#3 Abandon the asset entirely	#4 Diverting the asset into the bridge deck
Delivers business outcomes	Inadequate	Yes	Inadequate	Yes
Removal of safety risk	Inadequate	Yes	Yes	Yes
Effort to implement	Minimal	Maximal	Minimal	Average
Cost to implement	Not Obtained	Not obtained	[Cost-sensitive data]	[Cost-sensitive data]
Legal compliance	Not Compliant	Compliant	Compliant	Compliant

Figure 27 –[Security Data] Options Analysis

Option 1: Do nothing – discounted

This was not applicable for two reasons. The first was due to pipe scoring HI5 (Significant fault that requires immediate action) and due to [Third Party] electrification project resulting in works required to bring the crossing up to the required safety standard and remove smoke plates as these are within the OCLZ electrified zone. In addition, several encroachments were identified along this main and therefore a 'do-nothing' option was not viable as we needed to remove the risk of the encroachments of several domestic structures to the main. Therefore, this option was discounted.

Option 2: Keep the above ground crossing and carry out maintenance as this is scored as HI5 – discounted

Keeping the above ground crossing and not diverting into the new bridge deck would require us to carry out maintenance of the pipeline in line with our internal procedures as it is scored as HI5, requiring significant investment. The crossing needed to be brought up to the required standard in the 2023/2024 financial year due to HI5 scoring. Furthermore, [Third Party] planned on electrifying the railway November 2023, as such the remediation and plate removal works was needed to be undertaken by then costs involved in this remediation work and plate removal are significant. This option would also leave Cadent with the risk and costs involved with maintaining an asset spanning an electrified railway line. Therefore, it was discounted.

Option 3 – Abandon the asset – discounted

Our network analysis revealed that abandoning the overhead pipeline crossing on the bridge would not adversely affect the nearby network. However, this approach presents challenges in addressing multiple encroachments along the same segment of the MP main. Consequently, our proposed strategy involves abandoning this particular section of the main (depicted as a blue line in the referenced figures), but this necessitates keeping the crossing intact to maintain supply, with a preference to reroute it into the bridge deck.

Should we decide to abandon the crossing alone, it would then be essential to divert the section affected by encroachments. This diversion would require a considerable investment, complicated by factors such as obtaining lay consents on private land owned by [Third Party]. This complexity underscores the need for a balanced approach that efficiently resolves both the encroachment issues and the demands of maintaining the crossing.

Option 4 – Diverting the asset into the bridge deck – preferred

The primary objective of this project is to divert the existing above-ground main, currently running along the bridge, into the structure of a newly constructed bridge deck. This strategic diversion effectively resolves the encroachment issue by enabling us to abandon the pipeline adjacent to the railway track, which is marked as a blue line in the figures. Additionally, this approach eliminates the need for high maintenance of the asset, previously identified as HI5.

To ensure a continuous and uninterrupted supply, the project plan includes replacing the existing MP crossing with a more suitable 180mm PE main. Network analysis has confirmed that this replacement will effectively maintain consistent supply levels across the network.

Moreover, the new bridge's design thoughtfully includes a provision for a duct. This duct is specifically engineered to house the new 180mm PE main, ensuring its smooth integration with the existing infrastructure. The comprehensive details of

this scope of work are illustrated in Figure 28 below, providing a clear visual representation of the planned modifications and enhancements.

Figure 28 –[Security Data] Preferred Option

Chapter 3.5.3 – Preferred option

After careful analysis, the preferred solution is to reroute the pipeline into the new bridge deck being constructed by [Third Party]. This approach not only mitigates the risks and costs associated with maintaining an above-ground crossing over an electrified railway but also enables the abandonment of the encroached pipe (blue line). This is a more cost-effective solution compared to the expensive alternative of diverting the main at each encroachment point.

Risks and Project delivery timelines

Risk	Impact	Mitigation
Materials and Contract Labour Costs	Increased Cost to deliver project	Existing relationship with [Third Party] and local delivery partners. All works to be tendered and completed through the standard CMO processes and frameworks.

Figure 29 – [Security Data] Risks

- April 2023 - Need Identification and Assessment
- April 2023 - Detailed Design Completion
- May 2023- Project Sanction Date
- November-December 2023 – Cadent Mobilisation to site and abandonment of above ground crossing

- January-Feb 2024 lay and commission of new MP main within the bridge deck

Chapter 3.5.4 – Stakeholder Engagement

[Third Party] has a National Agreement introducing a new licensing system for all pipelines within [Third Party] land and bridges. This agreement mandates that we secure prior written approval before initiating any work, ensuring compliance with specific requirements regarding work schedules and site access. Furthermore, since this project is driven by [Third Party] primarily involving bridge demolition activities, they hold the authority to mandate us to complete our work within 12 months, with all associated costs borne by Cadent.

Chapter 3.5.5 – Cost Information

As this project is yet to be completed, the costs are derived using our target cost model and can be found in the "**[Security Data]**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker.**

Figure 30 – Total adjustment required – [Security Data] (18/19 prices)

Chapter 3.6 – [Sensitive Data] Diversion, [Security Data]

Chapter 3.6.1 – Problem Statement and Needs Case

A section of the [Security Data] pipeline runs through the [Security Data] industrial estate. A steel framed warehouse building, used by [Sensitive Data], encroached over the pipeline.

Figure 31 – [Sensitive Data] Encroachment

Investment Driver

In Summary the key investment drivers are:

- [Sensitive Data] is a commercial building with multiple occupants working there on a full-time basis. The encroachment posed a safety risk to the [Sensitive Data] staff and there was a safety risk of gas in building events and a risk of an explosion/fire.
- The pipeline is a single feed to [Security Data] and the surrounding area, therefore it was necessary to protect the integrity of pipeline and remove the risk of encroachment

Chapter 3.6.2 – Options Considered

Options Analysis Methodology

At a high level the options considered included:

- Option 1 – Do nothing
- Option 2 – Demolish and relocate the structure
- Option 3 – Abandon the asset entirely
- Option 4 – Divert the pipeline

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#1 Do Nothing	#2 Demolish the structure and relocate	#3 Abandon the asset entirely	#4 Divert the pipeline

Delivers business outcomes	Inadequate	Yes	Inadequate	Yes
Removal of safety risk	Inadequate	Yes	Yes, but as it is a single feed, this option was not considered	Yes
Effort to implement	Minimal	Maximal	Minimal	Average
Cost to implement	Not Obtained	Not obtained	Not obtained	[Cost-sensitive data]
Legal compliance	Not Compliant	Compliant	Compliant	Compliant

Figure 32 – [Sensitive Data] options analysis

Option 1 - Do Nothing (discounted)

This was not a suitable option at the time due to the risks associated with leaving the pipeline beneath a structure such as risk to life of the occupants of the building and, therefore this option was discounted.

Option 2 - Demolish Structure and Relocate (discounted)

There was no available land to relocate the building from above the pipeline. Any new location would not be acceptable to the businesses that occupy the offending buildings which would have ongoing cost to separate operations over two areas. At the time the landowner raised concerns to National Grid Gas Distribution senior management and their local MP over concerns around business loss and potential demolition of structure. Therefore, a deal was struck with [Sensitive Data] to pay a portion of the diversion cost.

Option 3 - Abandon Pipeline (discounted)

The pipeline is single feed to [Security Data] and surrounding area. Any loss of supply would result in many thousands of residences without gas.

Option 4 – Divert the main (preferred)

[Sensitive Data] agreed to allow us to carry out some preliminary work in their warehouse. Subsequently, our delivery partners delivered a cut out and abandoned the existing encroachment section of 42.3m pipeline and laid 68m of

200mm IP steel via open cut within the boundaries of [Sensitive Data]. The remaining section under the warehouse was decommissioned and abandoned.

Figure 33 - Resolution

Figure 33 shows the outcome of the diversion, with the encroached main highlighted in purple being abandoned and the main tied into the existing network.

Chapter 3.6.3 – Preferred Option

Option 4 was the preferred option as after all the others were considered we had no choice but to divert the pipeline away from the encroaching structure to remove the risk.

Chapter 3.6.4: Stakeholder Engagement

As outlined in option 2, we tried to go with the option to demolish the building and relocate the occupants but due to strong resistance from the building owner, associated legal challenges and strength of our legal position this option was discounted as the costs and time taken would have been substantial. Therefore, this stakeholder engagement impacted our choice of preferred option and we had to divert.

Chapter 3.6.5: Cost Information

As this is a retrospective application and Cadent has completed the work, the costs borne by Cadent as reflected in "**[Sensitive Data] Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker** are actual costs incurred**.**

Figure 34 – Total adjustment for [Sensitive Data] 18/19 prices

Chapter 3.7 – [Security Data]

Chapter 3.7.1 – Problem Statement and Needs Case

The Health and Safety Executive's (HSE) enforcement policy for the Iron Mains Risk Reduction Programme (IMRRP) addresses the failure of 'at risk' iron gas mains (i.e., those pipes within 30 metres of buildings) and the consequent risk of injuries, fatalities, and damage to buildings. It is designed to secure public safety whilst allowing efficiency, environmental, strategic and consumer service factors to contribute to driving the programme and allowing sufficient flexibility to enable Ofgem to incentivise innovation in risk management.

Item in scope

A newly developed housing estate on a previously unoccupied parcel of land shown in figure 35 falls within 30m of a Ductile Iron Medium Pressure (DIMP) main which is in scope of the HSE enforcement policy.

The main shown in figure 35 is single source, feeding 34,000 consumers in [Security Data]. The pipe is routed from [Sensitive Data] attached to a working [Sensitive Data] bridge to enable the supply to cross the [Security Data], which is over 300ft wide, the main then continues to run underground parallel to the railway within private land adjacent to the new development.

Figure 35 – [Security Data] DIMP

Investment Driver

- The driver of this scheme is to remove the DIMP via a diversion as per the HSE enforcement policy which has come about because of the development of a new housing estate.

- In addition to the need to replace this pipe due to the HSE enforcement, on the connected sections of steel and ductile iron there is a history of leakage. The scheme we are delivering will also address these issues.

Chapter 3.7.2 – Options Considered

Options analysis

At a high level the options considered included:

- **Option 1 –** Like for Like route
- **Option 2 –** IP to MP connection
- **Option 3 –** MP to MP connection
- **Option 4 –** Do nothing

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#Option 1 – Like for Like route	#Option 2 – IP to MP connection	#Option 3 – MP to MP Connection	#Option 4 – Do nothing
Delivers business outcomes	Yes	Yes	Yes	No
Removal of safety risk	Yes	Yes	Yes	No
Effort to implement	Maximal	Average	Maximal	Minimal
Cost to implement	Not obtained	[Cost-sensitive data]	Not obtained but assumed to be the most expensive option due to the length of the route	Not obtained
Legal compliance	Yes	Yes	Yes	No

Figure 36 – [Security Data] options analysis

Option 1: Lay like for Like as Close as Possible (discounted)

This route would come out of the existing governor at the ex-holder site and cross the [Security Data] via the exiting [Third Party] bridge and follow the route of the existing mains.

The existing pipe current route is beneath a freshwater culvert belonging to [Third Party]. To relay the pipe the culvert would require extensive work as well as working with the Environmental Agency to agree a route. This route would require 50m of floating pontoons to be installed across the span of this fast-flowing river to enable pipework to be connected to the railway bridge. Furthermore, an agreement with [Third Party] would also be required to ensure access to the bridge and environmental permission to float pontoons on the river.

Withstanding the cost implications of floating pontoons safety concerns were raised with this option as well as issues with ongoing maintenance and access to the pipe.

Figure 37a – Option 1 route

Option 2: Connect into Existing IP Network (Preferred Option)

This option abandons the pipes identified for replacement (indicated in yellow below) and connects the MP network to the IP network to the north east via a new IP to MP governor.

This option required the laying of 570m new 355mm MP main (note that as of time of writing 400m of this has been laid and can be seen on the diagram below - Phase 1). This main needs to tunnel under a railway track (indicated below) to then connect into a newly installed governor.

This option is preferred as it is deemed the most deliverable option with the least engineering challenges, minimising cost, and impact on consumers.

Figure 37b – Option 2 route

Option 3: Extend the MP Network from the north to Cross the River to the South (discounted)

This option abandons the pipes identified for replacement (indicated in yellow below) and connects the MP network north of the river to the MP network south of the river.

To deliver this would require 1.75km of new MP main and the crossing of two bridges (one rail and one across the river) as well as tunnelling under a railway line.

The length and cost of the new MP main and associated engineering challenges of crossing two bridges and the railway crossing along with the timescales involved in getting approval of the stakeholders involved in the route made this option not viable.

Figure 38 – option 3 route

Option 4 – Do nothing (discounted)

Option 4, which has been discounted, would either leave the decommissioned iron mains in place, contravening Health, and Safety Executive (HSE) policy, or abandon the main entirely. However, this is not feasible as it is the sole supply to [Security Data] low-pressure network, catering to 34,000 consumers.

Chapter 3.7.3 – Preferred Option

Preferred Option rationale and consumer benefit

The option to divert the pipeline has a number of benefits including the removal of the DIMP, removal of mains which have a leakage history, removal of above ground crossing, removal of pipework from private land.

Compared to the other options available the preferred option is deliverable, reduces the number of crossing inspections and minimises environmental impact of the remediation of the DIMP.

The only drawback of the scheme is the complexity of crossing a railway track, however this is the least complex solution identified.

Scope of works

- Secure Land for New Governor [Security Data] Council)
- Obtain Planning Permission for new Governor [Security Data] Council)
- Install new IP/MP Governor and connect to the existing IP main in [Security Data]
- Use a Micro Tunnel to access the land on the [Sensitive Data] tunnelling under the
- Extend the MP Pipeline from the Junction of [Sensitive Data] to the Route agreed with [Sensitive Data]
- Connect the MP pipe from the Outlet of the New Governor 450mm and 355mm in to the newly laid main in [Sensitive Data] Via the Micro tunnel under the [Sensitive Data] and connect to the main at the Tee Junction on [Sensitive Data]. Circa 200m + 130m 355mm.
- Order Specialist fittings for IP connection (Grouted Tees etc)
- Decommission the MP DIMP main at the Holder station and at its connection point on [Sensitive Data].

Project Risk

Risk	Impact	Mitigation
Ignition Sources	• Fire • Explosion • Environmental impact	Intrinsically safe tools and equipment are to be used where possible during construction. The kiosk location has been considered during the design.
External Failure Causes – caused by third party interference	• Reputational damage • Financial impact • Environmental impact	The pipeline will be buried with no exposure Location of the governor is housed within a secure kiosk.
Impact Damage caused by vehicle collision or falling tree	Asset damage	Kiosk location outside of tree canopy and clear of root protection area.

Figure 39 – [Security Data] Risks

Timelines

- Connect the MP pipe from the Outlet of the New Governor 450mm and 355mm in to the newly laid main in [Security Data] Via the Micro tunnel under the [Sensitive Data] rail tracks] and connect to the main at the Tee Junction on [Security Data]. Start **Jan 24** complete works **July/August 24**

- Secure Land for New Governor ([Security Data] Council) Licence agreed and costs of temporary compound Granted **Jan 24**

- Obtain Planning Permission for new Governor ([Security Data] Council) – **Feb 24**

- Install new IP/MP Governor and connect to the existing IP main in [Security Data] **Feb/ March 24,** completion expected **April /May 24**

- Use a Micro Tunnel to access the land on the [Security Data] Development from the Junction of [Security Data] to the Route agreed with [Security Data]. Tender for Tunnelling issued **Feb 24.** Work to commence **April/May 24**. Tunnel set to be completed **June/July 24**

- Decommission the MP DIMP main at the Holder station and at its connection point on [Security Data] **July/November 24**

Chapter 3.7.4 – Stakeholder Engagement

Multiple stakeholders are actively engaged in various aspects of the project. [Third Party] is involved in optioneering for the diversion route and addressing access and land requirements for tunnel connection. [Security Data] is focused on tunnelling location and potential track realignment. [Security Data] Council plays a pivotal role in land negotiations for the governor's position, securing lease agreements for car park use during tunnelling and obtaining planning permission for the governor's construction. [Security Data] is working on land permissions and easements for the new pipeline, and customer engagement efforts are planned for localised communication when pipe laying begins to ensure stakeholders are well-informed and engaged throughout the project.

Chapter 3.7.5 – Cost Information

The cost information below is based on a combination of actual project costs incurred for activities related to tunnelling design and lay of MP main. In addition, a cost for a governor was based on a quote received from the contractor delivering the work. There is currently an estimate based on historic projects of a similar nature for the tunnelling & IP lay. However, we are currently in the process of acquiring accurate quotations for this aspect of the project.

Figure 40 – Total adjustment for [Security Data] (18/19 prices)

Chapter 3.8 - Project 5 [Security Data]

Chapter 3.8.1 - Problem Statement and Needs Case

Cadent own and operate an IP pipeline that has been encroached as it currently runs directly under the southern maintenance shed at [Security Data] site. We have a requirement to divert the encroached section of this IP pipeline around and away from the maintenance building.

Figure 41 –[Security Data] encroachment

The Investment driver is removal of the risk caused by encroachment such as damage to pipeline integrity, and safety concerns if gas were to leak into the maintenance building. A feasibility study has been carried out, but the project has yet to progress to the detailed design stage as the route for the preferred option is currently being finalised. [Sensitive Data], an engineering services company were engaged by Cadent to carry out the feasibility study for the removal of risk on this section of the IP pipeline, the narrative below is a summary of the outputs of that feasibility study, which can be found in **Appendix 7 – [Security Data] feasibility study.**

Chapter 3.8.2 – Options Considered

Four pipeline route options and two non-diversion options were considered. The first 3 options involve under track crossings (UTX) while the 4th involves an over-track track crossing (OTX). The 4 route options considered are summarised as follows:

- Option 1 – 187m diversion with open cut excavations
- Option 2 – 120m diversion with open cut excavations
- Option 3 – 442m diversion with trenchless and open cut excavations
- Option 4 – 1630m diversion with open cut excavation
- Option 5 – Remove the maintenance building
- Option 6 – Abandon the main
- Option 7 – Do Nothing

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#Option 1 – 187m diversion	#Option 2 – 120m diversion	#Option 3 – 442m diversion	#Option 4 – 1630m diversion	#Option 5 – Remove the maintenance building	#Option 6 – Abandon the main	#Option 7 – Do nothing
Delivers business outcomes	Yes	Yes	Yes	Yes	Yes	Yes	No
Removal of safety risk	Yes	Yes	Yes	Yes	Yes	Yes – but leads to loss of supply	No
Effort to implement	Average – but discounted due to [Third Party] considerations	Average – but discounted due to [Third Party] considerations	Maximal	Maximal	Minimal	Minimal	Minimal
Cost to implement	Not applicable as option as discounted due to [Third Part]	Not applicable as option as discounted due to [Third Party]	Most expensive option due to complexity of the work	[Cost-sensitive data]	Not obtained	Not obtained	Not obtained
Legal compliance	Yes	Yes	Yes	Yes	Yes	Yes	No

Figure 42 – [Security Data] options analysis

Option 1 - 187m Diversion with Open-cut excavations (discounted)

This option involves diverting the pipeline south of the maintenance building with open cut excavation techniques. This pipeline route runs from a field east of the [Third Party] site boundary to the west side of the maintenance building and will cross three maintenance railway tracks that run from the maintenance building as shown in Figure 43 below.

Figure 43 – Option 1

The benefits of this option are there is no electrical apparatus or water main along this route. Furthermore, the field area also provides an option for site establishment should there be an issue with space availability on the main site. The field can be easily accessed via the south-east. Another benefit of this option is that depth of cover at the east tie-in point is circa 1m which makes for significantly less excavation work when compared to the east tie-in point of option 2.

It was also considered to tunnel beneath the maintenance tracks; however, this approach was discounted because of the limited space between the refuelling and the maintenance tracks for a receipt/launch shaft or a drill rig. During the feasibility study and early engagement, it was understood that [Third Party] expressed the possibility of the temporary removal of the tracks during the initial discussions with Cadent. However, this proposal was later rejected by [Third Party] due to concerns around track outages and delays to maintenance schedules. Therefore, this option was discounted. Issues around the pit to the west due to the depth of the main and the size of the pit required the limited space between the building and track meant that there would be a risk of undermining the railway or causing damaged which was unacceptable to [Third Party] and [Third Party].

Option 2 – 120m diversion with Open-cut excavations (discounted)

For pipeline route option 2, the proposal is to construct the pipeline diversion by means of the open cut method only. The route as shown in figure 44 below will run from the west to the east side of the building and shall require the tracks along the route to temporarily be removed to enable construction work.

Figure 44 – Option 2

The east side of the building serves as one of the accesses to the south side of the building and with the pipeline being circa 9m deep at this location, this area will be inaccessible during construction works. Temporarily fencing off this access area may have an impact on the fire escape plan of the building. Therefore, due to these associated risks this option was discounted by [Third Party]. In addition, this option was also discounted for the same reasons as option 1.

Option 3 – 442m Diversion with Trenchless and Open-cut excavations (discounted)

Pipeline route option 3 is similar to option 1 but with a longer trenchless crossing requirement. It is proposed to have the same tie-in point on the east side as route option 1 but diverts further to the west of the [Third Party] site boundary. The purpose of this west tie-in location is that it provides construction access and sufficient room for a receiver/driver pit for the trenchless crossing. The trenchless crossing will cross multiple rail tracks which include the maintenance, refuelling, cargo, and several passenger tracks.

Figure 45 – Option 3 route

Consideration was given to having this route option run north of the building but was discounted based on the presence of trees and ditches in the northeast area would pose a significant issue with accessing that area for construction activities.

This option was discounted in favour of the preferred option (option 4) due to the additional risk and cost associated with crossing multiple railway lines.

Option 4 – 1630m Diversion with Open-cut excavations (preferred)

For pipeline route option 4, it is proposed that a new pipeline be constructed to connect the HP/IP governor at (1) and the IP/MP governor at (2) shown in figure 46. The route of this pipeline will run along the [Third Party] train care access road, [Security Data] and [Security Data] bridge as shown in the figure 46. This proposed route will mean a complete abandonment of the existing IP pipeline shown in figure 47 below. This option also has the additional benefit of removing access issues on the section to be abandoned, as any future maintenance or repair works would be hindered by the presence of the rail lines above.

2

1

Figure 46 – Option 4

Figure 47 – option 4

There are a number of existing buried services routed along this pipeline route such as low-pressure gas (Cadent owned), HV and LV electricity, telecoms, and water main. It is recommended by [Security Data] that Cadent identify the exact location and depth of these services early in the detailed design phase and engage with all relevant stakeholders to ensure crossing agreements and/or diversion of services, if required.

It is likely the three roads along this route will need to be partially closed and controlled using traffic management systems.

[Sensitive Data] Project – New Foot Bridge Scheme

There was a scheme currently in the feasibility stage under [Sensitive Data] to have two new footbridges on either side of the of the [Security Data] bridge to help ease the traffic on the bridge. This was mentioned in the feasibility study as part of Option 4 as it may have been possible to incorporate this pipeline route into the design of these footbridges before construction began in 2024. However, it is believed that the scheme has been cancelled as part of the scope reduction of [Sensitive Data].

Figure 48 - North foot bridge

Figure 49 – South foot bridge

[Security Data] Bridge Consideration

The [Security Data] bridge is owned and managed by [Third Party] and routing along this bridge will be subjected to their approval process just like the other options discussed in this report.

Option 5 – Relocate the Maintenance Building (discounted)

There is suitable room to the north area of the current building for the relocation/rebuild of the maintenance building. Furthermore, the relocation could be done in two ways shown below. The first could be to maintain a portion of the

existing footprint by modifying the building to extend northwards so that the area over pipeline can be removed. The second could be complete relocation/rebuild of the maintenance building further northwards. However, as mentioned above, due to the disruption to [Third Party] business, and the associated cost, meant that the structure relocation was ruled out.

Figure 50 – Modify the existing building

Figure 51 – Complete relocation of the maintenance building

Option 6 – Abandon the main (discounted)

This gas pipeline is the sole feed to the [Security Data] network which feeds into three downstream IP/MP regulators providing gas for around 52,000 supplies downstream of the MP and LP networks. Therefore, it cannot be abandoned.

Option 7 – Do nothing (discounted)

Under the Pipeline Safety Regulations (PSR) Regulation 13, we must maintain our pipelines safely and efficiently. The maintenance building in question presents a considerable risk to the integrity of our intermediate pressure pipeline, which serves thousands of customers. Additionally, it poses significant safety risks to the building's occupants. Consequently, the 'do nothing' option was deemed unsuitable due to these substantial concerns and subsequently dismissed.

Chapter 3.8.3 – Preferred Option

Preferred Option Rationale

[Security Data] noted that should it be confirmed that is not possible to remove the tracks for pipeline route option 1 or 2, the recommended pipeline diversion would then default to option 3. Option 4 would only come into consideration if options 1, 2 and 3 are considered not feasible. As outlined above, options 1 and 2 were discounted because of [Third Party] considerations. Option 3 is considered the most expensive and challenging option; therefore, Option 4 was the only option that was feasible.

Benefits and Drawbacks of the options selected:

Option 1	
Strengths	**Weaknesses**
• No trenchless crossing involved • Shorter route compared to options 3 and 4 • Excavation at the east tie-in point will be circa 1m. • Provides an opportunity to utilise [Sensitive Data] stopple technology at the west tie-in location	• Deep excavation – Robust temporary works design required at the west tie-in point • Diversion remains beneath maintenance tracks. • Limited space for traditional double stopple bypass on the west tie-in • Route crosses boundary's embankment • Diversion still remains beneath maintenance track • Unknown ground conditions • Option rejected by [Third Party]

Option 2	
Strengths	**Weaknesses**
• No trenchless crossing involved • Shortest route option • Construction activities are within the [Third Party] site boundary • Provides an opportunity to utilise [Sensitive Data] stopple technology at both tie-in locations	• Deep excavation – Robust temporary works design required at both east and west tie-in points. • Limited space for traditional double stopple bypass on the west tie-in and east tie-in locations. • Could impact access around maintenance building. • Diversion still remains beneath maintenance track • Unknown ground conditions • Option rejected by [Third Party]
Options 3	
Strengths	**Weakness**
• Ample room for traditional stopple and bypass arrangement for both east and west tie-ins. • Tracks remain operational during construction activities.	• Second longest route overall. • Upgrade maybe required on the CP system for this route option. • Crosses multiple rail tracks – maintenance, refuelling, cargo, and several passenger tracks. • Long trenchless crossing • Third party access/agreements are required for site establishment and constructions activities • Most expensive option • Unknown ground conditions • Risk of settlement along several tracks
Options 4	
Strengths	**Weakness**
• Route will completely avoid all of [Third Party] tracks. • Route will remove the pipeline from [Third Party] maintenance boundary • Completely removes the IP from underneath all rail tracks within the [Security Data] station Area.	• Longest route overall • Highest environmental impact • New easements required • Longest construction duration • Route involves complex street works – traffic management and road closures

• Tracks remain operational during construction activities.	• Multiple services along route – gas, LV electricity, network, drainage • Route involves overground track crossing OTX. • Design work required to confirm if an OTX is possible on the [Sensitive Data] bridge

Figure 52 – Options comparison

Project Risks

The following key risks have been identified as those that potentially present a risk to the successful completion of the project.

Project Risk	Description
Long-lead materials	Durations of up to 40 weeks can be expected for some materials that will dictate the start of construction.
External services and contractor appointment	Various sub-contractor services will need to be engaged in a timely manner.
Connections	The pipeline where the proposed hot taps are to be made should be excavated and assessed prior to ordering hot tap materials. The weld locations and sections of straight suitable pipe should be identified for the connection tie-ins
Venting operations	Gas plumes can present an ignition hazard and venting may be noisy and disruptive to persons working in and around the train maintenance building. Notifying [Sensitive Data] about this can partially mitigate the hazard
Environmental	Unforeseen issues or discovering and mitigating protected species could be identified and impact on the programme.
Settlement Risk	For [Third Party], the risk of primary concern is usually related to tunnel face stability and the potential for excessive ground loss during micro-tunnelling that could lead to surface settlement migrating upwards and laterally, adversely affecting the existing railway lines. This is not a risk with the proposed pipeline route option 1.
Pipeline Tie-in Methodology	Delay in Cadent's G23 approval of [Sensitive Data] tool required for options 1 and 2.

Figure 53 –[Security Data] Risks

Project Timelines and Milestones

- Detailed design work, tender, and award to contractor completed in year 2024/25

- The project is planned for construction in year 5 of GD2 (preliminary target start date 01/04/2025, completion date 31/10/2025)

- Currently there are no concerns around resource availability as tendering to market should provide a wide pool of resources.

- Due to the long lead time required for the delivery of this diversion, additional monitoring via remote gas detection equipment is being put in place, on top of the standard leakage checks (carried out on a 14-day frequency). This monitoring should also manage the risk in the event that the target completion date cannot be met.

- Project progress will be monitored by the [Security Data] Investment Planning Office and measured against the target dates set out at the award stage. Full details of milestones, timelines, and the level and frequency of delivery monitoring will be established after the detailed design is completed.

Chapter 3.8.4 - Stakeholder Considerations

The site on which the encroachment is located is owned by [Third Party] and leased to [Third Party]. Both have been engaged with, directly and through Cadent's land agents, regarding the options for diverting the pipeline and the possibility of relocating the structure infringing Cadent's asset.

This process has been complicated and drawn out for several reasons. Firstly, there are plans to build a new road east of the site, providing a different access point for [Third Party] and avoiding crossing the railway tracks. This potential change affects how we divert our pipeline. Additionally, government decisions regarding the [Sensitive Data] and delays have altered Cadent's planning and approach. Another primary concern has been ensuring safety and feasibility, especially since any work would occur close to [Third Party] tracks.

The idea of moving the interfering structure was dismissed due to the disruption and costs it would impose on [Third Party] operations. Also, because any work near the train lines could affect access to [Third Party] maintenance shed, this ruled out the first two proposed pipeline diversion options, which were shorter and more direct.

We are focusing on Option 4, conducting site visits, and working on a detailed design for this solution. This option involves diverting the pipeline along public roads, which means the local highway authority must be involved in the planning stages. Cadent will need their input and agreement before finalising the design.

It's important to note that since this project takes place on [Third Party] land, Cadent must adhere to [Third Party] terms. Moreover, any costs for the diversion work will be borne by Cadent.

Chapter 3.8.5 – Cost Information

As part of the [Sensitive Data] feasibility study, high level budget costs for our preferred route option 4 were provided on page 36 of the report appended **Appendix 7 – [Sensitive Data] feasibility** along with the costs of the other options. The budget costs presented are +/- 20%. We have presented the costs for our preferred option 4 below with the assumption of +20% on construction costs based on the complexity of this route and the expected costs associated with planning and consents. This can be found in the "**[Sensitive Data] Costs**" tab of **Appendix 1 – Diversions Re-Opener Finance Tracker.**

Figure 54 – Total adjustment for[[Security Data]

Chapter 3.9 – [Security Data]

Chapter 3.9.1 – Problem Statement and Needs Case

When carrying out a valve maintenance survey, a 315mm PE MP main was discovered to have been encroached by stairwell extension to [Security Data]. The investment driver for this project is to divert the main away from the stairwell to reduce safety risk and comply with engineering procedure.

Figure 55 – [Security Data] Encroachment

Chapter 3.9.2 – Options Considered:

Cadent options analysis

Option 1: Structure removal
Option 2: Abandon the main entirely
Option 3: Diversion
Option 4: Do Nothing

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#Option 1 – Structural removal	#Option 2 – Abandon the main entirely	#Option 3 – Diversion	#Option 4 – Do nothing
Delivers business outcomes	Yes	Yes	Yes	No
Removal of safety risk	Yes	Yes	Yes	No
Effort to implement	Maximal	Minimal	Average	Minimal
Cost to implement	Not obtained	Not obtained	[Cost-sensitive data]	Not obtained
Legal Compliance	Yes	Yes	Yes	No

Figure 56 –[Security Data] Options analysis

Option 1 - Structure removal (discounted)

The building underwent significant renovations leading to this encroachment through a stairwell extension. Structure removal is not considered to be a viable option due to the impact it would have on the residents staying in the building and impacting one of their entry/exit access levels in the building. Structure removal would potentially cost more than diverting the main especially when considering likely structure reinforcement works and the need to find an alternative. Consultation with external lawyers concluded that we were not guaranteed a successful outcome in trying to pass costs onto the building owner and could entail a lengthy and costly legal process to arrive at a decision.

Option 2 – Abandon the main entirely (discounted)

This is not a viable option, as this 315mm MP main is a one way fed main, and this is an only supply to the downstream of the MP network, feed to more than 7000 customers.

Option 3 – Diversion (preferred)

Abandon 62 meters of the compromised 315mm PE MP main. Lay 55 meters of new 315mm PE main via open cut in carriage way/footway/verge, including installation of three 300mm inline valves.

Design takes into consideration minimising the length of the diversion and connections to be made as well as practicalities in achieving a compliant route (e.g. building proximity distances etc.) that can be constructed safely.

Option 4 - Do Nothing (discounted)

This option was discounted due to the risks associated with the stairwell encroaching over the main such as pipeline integrity and lack of access for maintenance.

Chapter 3.9.3 – Preferred Option

Preferred Option Rationale and Consumer Benefit

- Removes the risk from the encroached main and limits the footprint of mains on site to minimal LP and MP mains connections to the Governor.
- Minimised footprint on site and achieves an efficient route for the new pipe.
- Minimal disruption to residents with connection excavations undertaken within carriageway, whilst also avoiding the need for an easement

Project Risks and Timelines

Risk	Impact	Mitigation
Open cut route not viable / difficult due to other utilities in proximity.	Potential for delays and increased costs	Conduct utility search and surveys to identify and plan around the existing utilities.
Delay from local authorities	Extended project duration which may result in increased costs	Early engagement and clear communication with local authorities. Produce and submit plans for approval and engage effectively with owners of structure.
Operating windows	Limited work hours could delay the project	Accurate scheduling to maximise efficiency within the given operating windows

Figure 57** [Security Data] **Risks

Timelines

- Tender return - W/c 19th Feb 24
- Tender Award – W/c 4th March 24
- Mobilise – Q1 24/25 (dependent on NRSWA permits)
- Completion – Q2 24/25
- Project duration – indicative programme 38 days.

Chapter 3.9.4 – Stakeholder Engagement

The selection of the preferred option for the project was decided by engaging with stakeholders from Design, Energy Operations, Commercial, Lands, and Legal departments. The Design team considered different diversion routes and its technical feasibility, ensuring reliable work completion. Energy Operations provided an operational perspective, focusing on minimal disruption on site, providing gas mains and site information to help make an informed decision. The Commercial team will secure the best prices through a tender event and identify the most suitable supplier. Lands team insights were crucial for addressing land use and property implications, ensuring the chosen route was legally and practically viable. Finally, the Legal team ensured regulatory and legal compliance, provided a view on our legal rights against the different options and safeguarding against legal risks. This collaborative approach led to a well-rounded, sustainable option.

Chapter 3.9.5 – Cost Information

A cost estimate was created by our diversions and commercial teams based on assumptions from our asset records and network models. This is similar to our target cost model. This can be found in "**[Security Data] Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker**.

Figure 58 – Total adjustment [Security Data]

Chapter 3.10 – [Security Data]

Chapter 3.10.1 – Problem Statement and Needs Case

This project is to address a critical safety concern involving the diversion of a 48-inch Cast Iron Medium Pressure pipeline being encroached by a substantial integral structure. The pipeline's proximity to key substation assets and its history of leakage issues increases the potential risk. The investment driver is to remove the risk posed to the occupants of the building and risk to the integrity of the pipeline.

Figure 59 – [Security Data] Encroachment

Chapter 3.10.2 – Options Considered

Options analysis

- **Option 1**: Diversion Route 1
- **Option 2**: Diversion Route 2
- **Option 3**: Diversion Route 3
- **Option 4**: Structural Removal
- **Option 5**: Abandon the Asset
- **Option 6**: Do nothing

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#Option 1 – Diversion Route 1	#Option 2 – Diversion Route 2	#Option 3 – Diversion Route 3	#Option 4 – Structural removal	#Option 5 Abandon the asset	#option 6 Do nothing
Delivers business outcomes	Yes	Yes	Yes	Yes	Yes	No
Removal of safety risk	Yes	Yes	Yes	Yes	Yes	No
Effort to implement	Maximal	Average	Average	Maximal	Minimal	Minimal
Cost to implement	Not obtained	[Cost-sensitive data]	Not obtained	Not obtained	Not obtained	Not obtained
Legal Compliance	Yes	Yes	Yes	Yes	Yes	No

Figure 60 – Security Data] Options analysis

Option 1: Diversion Route 1 (discounted)

This would have seen a new 630mm PE main laid by open cut trench through the entrance to the [Third Party] substation, then inserted in the existing 48" CI main towards the [Security Data] to the Southeast. GPR scans were completed to determine whether the route was clear of other utilities, and a route was successfully plotted following the results. However [Third Party] withdrew from the negotiations with concerns over access and security whilst the project was ongoing. An alternative option was therefore required.

Figure 61** – [Security Data] **Option 1

Option 2: Diversion Route 2 (1st preference)

This option was to lay a new 630mm PE main through the [Security Data], terminating in the [Security Data] car park to the south. The original plan was to pursue this route but the landowners at the time were unwilling to agree to an easement which suitably protected our rights in the future. The landowners have recently changed to [Security Data] and subsequent to a meeting a high-level plan was provided to them. [Security Data] denied access for this option due to the disruption envisaged to their commercial tenants. We are still pursuing a dialogue to determine whether appropriate arrangements can be put in place to minimise disruption to the commercial businesses.

Figure 62 –[Security Data] Option 2

Option 3: Route 3 (2nd preference)

This option is to lay a new 630mm PE main to the rear of the [Security Data] commercial units. There is limited space here, and there would be a requirement to temporarily dismantle [Third Party] high security fence and access their site during the construction. Negotiations are currently underway with [Third Party] regarding this but there are likely to be further concerns regarding maintenance of security to this CNI site whilst the project is ongoing. Further pre-construction work would also be needed to prove the main could be installed without adversely impacting the commercial unit structures.

Figure 63 – [Security Data] Option 3

Option 4 – Structural removal

This option would entail entering into dialogue with the landowner to dismantle the structure and relocate. The structure is a large one and an important part of the landowner's business. After consultation with external lawyers, it was determined that we would not be guaranteed a successful outcome if we pursued our rights under an existing easement to have the structure removed. Therefore, we would need the landowner to agree to remove the structure, but this would leave Cadent potentially liable for the costs to remove the structure, establishing and paying for a replacement structure (if viable) and open to loss of business claims during the process. This would likely be a very difficult and lengthy process and without assurance of a successful outcome especially against a known, difficult landowner. Considering the cost, risk and effort involved, this option was discounted in preference for a new route that would also protect the future integrity of the pipe given the route through [Security Data].

Option 5 – Abandon the main entirely

Network Analysis was undertaken to determine whether the main could be abandoned. The main is a key part of the MP network and analysis highlighted a significant reduction in resilience without the supply being maintained. This 48" main is a sole feed [Sensitive Data] and has a capacity of over 70,000 scm/h providing resilience to the [Security Data] network in case of failure on [Security Data]. This section of MP pipeline is a major backup supply to the network, hence the option of permanent abandon of 48" main was discounted.

Option 6 – Do nothing

This option was not considered due to the safety risks posed to the occupants of the building and the integrity of the pipeline.

Chapter 3.10.3 – Preferred Option

Preferred Option Rationale and Consumer Benefit

The preferred option most effectively mitigates the safety concerns as well as protecting the future integrity of the pipe. By diverting the main we will remove the risk from the encroachment along with the associated potential consequences in the event of a catastrophic failure.

The intended option will support decommissioning of a length of the existing main which is in close proximity to [Sensitive Data] – maintaining this pipe given the age and likely deterioration will be very challenging and risks disrupting [Sensitive Data]. The diversion route will remove this risk and support easier future maintenance.

The preferred option supports the ongoing security of supply and resilience to [Sensitive Data].

Given the location there is no easy option especially due to congestion with other utility infrastructure. Allied with the engineering challenges in completing the construction work and potential customer disruption, this project will incur reasonably significant costs, which will only be fully understood once a viable option is confirmed, and a tender event held with our supply chain.

Project Risks and Timelines

Risk	Impact	Mitigation
Pipeline damage	Pipeline damage could cause the pipe to leak and pose a safety hazard.	Regular leakage surveys conducted and prioritising confirmation of a viable diversion route.

Access denial	Failure to secure access to lay a new pipe	Engage in proactive and continuous negotiation with stakeholders ([Security Data]) and consider their requirements to avoid negotiations failure. Last resort option is to replace the pipe in situ and seeking appropriate engineering deviation / mitigation to reduce the safety risk as much as possible.
Construction challenges	Significantly increase cost of the project	Undertake pre-construction work to validate route of pipeline and identify any key risks to the Principal Contractor. Undertake competitive tender event to drive best value from supply chain

Figure 64 – [Security Data] Risks

Timelines

- Option finalisation: Apr-2024
- Land negotiation / easement as required: Q1-Q2 2024/25
- Detailed design / pre-enabling / Tendering: Q3 2024/25
- Construction: Q4 2024/25 – Q1 2025/26

Chapter 3.10.3 – Stakeholder Engagement

Several stakeholders have been consulted, particularly [Third Party], [Third Party] and the landowners of the [Security Data] in order to determine a viable option for the diversion. Early dialogue with the landowner about the structure was also undertaken but options to progress structure removal were not feasible as described earlier. The dialogue is ongoing along with plans for further pre-construction work. If one of the preferred options is viable then an easement will need to be agreed with the landowners as well as discussions on how to mitigate disruption during the construction phase.

Chapter 3.10.4 – Cost information

Our analysis of the options indicates that option 2 is our first preference, followed by option 3. We have established Target Costs for option 2, and even if option 3 emerges as the more favoured choice, the costs projected for option two will still serve as a reliable cost baseline for both options. You can find the target costs in the "**[Security Data] Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker.**

Figure 65 – Total adjustment for [Security Data] 18/19 prices

Chapter 3.11 – [Security Data]

Chapter 3.11.1 – Problem Statement and Needs Case

The driver of this project is to remove the risk of multiple encroachments on our assets by a series of domestic structures such as garages and outbuildings on our Intermediate pressure pipe (show in green in figure 66 below) in [Security Data].

Figure 66 – [Security Data] Encroachment

Investment Driver:

The driver of this project is to remove the risk posed by the encroachments on our asset. The risks are summarised below:

- Our asset is a single feed intermediate pressure pipeline that feeds 8,000 customers, the encroachments pose a risk to the integrity of our asset and there is a risk it could lead to loss of supply to said customers.

- The encroachments pose risks such as fires, explosions, and gas in building events to the occupants of the various encroaching structures.

- Our access rights under the PSR to maintain our asset in a safe and efficient manner are prohibited by the encroaching structures.

Chapter 3.11.2 – Options Considered

- **Option 1** – Do nothing
- **Option 2** – Abandon main only
- **Option 3** – Remove Structures
- **Option 4** – Diversion Route 1
- **Option 5** – Diversion Route 2

To determine the most suitable solution to deliver the resolution required, each potential option was evaluated against the overall Cadent business objectives. The definitions of each business objectives can be found in **Cadent's Options Analysis Methodology (Appendix 3).**

	#Option 1 – Do nothing	#Option 2 – Abandon main only	#Option 3 – Remove Structures	#Option 4 – Diversion Route 1	#Option 5 – Diversion Route 2
Delivers business outcomes	No – as encroachment risk remains	Abandonment of the pipeline would remove the safety risk but would lead to loss of supply	Yes – safety risk is removed	Yes	Yes
Removal of safety risk	No	Yes	Yes	Yes	Yes
Effort to implement	Minimal	Minimal	Maximal	Average	Maximal
Cost to implement	Not obtained	Not obtained	Not obtained	[Cost-sensitive data]	Not obtained
Legal compliance	**No**	Yes	Yes	Yes	Yes

Figure 67 –[Security Data] Options analysis

Option 1 – Do nothing (discounted)

As outlined in the investment driver this option was discounted as we have an obligation under the PSR to maintain our asset safely and efficiently, in addition the risks to customers and the integrity of our single feed asset meant this option was discounted.

Option 2 – Abandon main only (discounted)

Our pipeline is a single fed system and if we abandoned our asset to remove the risk, there would be approximately 8,000 homes and businesses without a gas supply, as this pipeline carries gas to several district governors in the area. For this reason, this option has been discounted.

Option 3 - Remove the offending structures (discounted)

Our land officers engaged with the owners of the various structures requesting the removal of the offending structures and carried out negotiations to offer compensation to remove the structures as this seen to be the most efficient option at the time. However, due to their being multiple customers involved and the strength of our legal position in pursuing the removal of multiple structures and the associated legal costs and duration of legal proceedings this option was discounted.

Option 4 – Diversion Route 1 (preferred)

Route 1 would involve laying 166m pipeline onto the main road away from the offending structures as shown in the figure 68 below, this option removes the risk of future encroachments as the asset is in the main road and removes the risk in future if other structures like sheds, conservatories were erected.

Figure 68 – [Security Data] option 4

Option 5 – Diversion Route 2 (discounted)

The same factors considered in option 4 were factored into the design of route 2. However as this is a longer route and there is a risk it could cause prolonged disruption on [Security Data] due to longer time need to deliver this longer diversion, and assumed higher cost compared to option 4 this option was discounted.

Figure 69 – [Security Data] Option 5

Chapter 3.11.3 – Preferred Option

Preferred option rationale and consumer benefit

Option 4 is our preferred option as it is the shortest diversion route and we have considered efficiency in mind as it places the main onto a main road and therefore removes the risk of future encroachments. Furthermore, this option removes the safety risk to the customers of the offending structures as it diverts the pipeline away from the encroachments.

Scope of work

- Installation of tee connections into the IP main
- Lay a 250mm HDPE pipe (166m in length)
- Cut and cap and abandon the encroached section

Project timelines and risks

Timelines

- Competitive Tender - April 2024
- Detailed Design and planning - June 2024
- Completion - June 2025

Project Risks

Risk	Impact	Mitigation
Possible extension to diversion route due to pipeline condition in two connection/tie in locations on the IP system.	If the two connection/tie in locations are unsuitable there is a risk cost could increase slightly due to having to extend the diversion to an acceptable condition location.	During the detailed design stage steps will be taken to analyse the best possible connection/tie in location to avoid extending the diversion route.
Other utilities assets could obstruct the route in our preferred option.	The route proposed in our preferred option might deviate leading to increased costs.	During the detailed design/ planning stage surveys will be conducted on the proposed route identifying the exact location of the utility mains and taking measures to avoid them.

Figure 70 – [Security Data] Risks

Chapter 3.11.3 – Stakeholder engagement

Stakeholder engagement was deemed unnecessary in this scenario, as there were no significant stakeholders impacted by the selection of the preferred option. Option 4 entails a diversion onto main road, without involving complex issues related to land ownership or similar concerns, given its location on a public road.

Chapter 3.11.4 – Cost Information

As construction of this project is yet to be begin, the costs are derived using our target cost model and can be found in the "[Security Data] **Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker.**

Figure 71 – Total adjustment for [Security Data] (18/19 Prices)

Chapter 3.12 –Third-party encroachment of services

Problem Statement and Needs Case

Chapter 3.12 outlines the risks associated with encroachments of our service pipes, resolutions options and cost recovery methods. In addition, we have provided cost information for actual costs incurred and a forecast methodology.

Overview of Third-Party Encroachment of Services

An encroached service is a gas service that has been compromised by building work resulting in creation of an unsafe situation as identified within the Gas Industry Unsafe Situations Procedure (IGEM/G/11). As required by the industry standard and to ensure legislative compliance with PSR, Cadent is required to address all encroached service cases.

Items in scope

The actions required for resolution of an encroached over service are to either:

- Alter the position of the service to one which is compliant with current industry standards.
- Remove or modify the offending structure to create compliance.

The removal or modification of the structure to create compliance is often not one the consumer accepts. Therefore, the default (and only legal) option for Cadent to resolve the situation is to alter or relay the service pipe under the Gas Act.

Chapter 3.12.1 Options considered

When a structure like a porch is encroaching over or near a gas service pipe, service relay or alteration may be necessary.

Service Relay: If the material is metallic a service relay is required which involves installing a new pipe along an unobstructed route for safe and accessible maintenance.
Service Alteration: If the material is PE alteration can take place. This involves altering the pipe's route to bypass the encroached area can maintain uninterrupted and safe gas supply.

Example of an encroached service

Figure 72 – Examples of an encroached service

Encroaching or compromising the position of a gas service pipe has the potential to pose a serious risk to life and property.

- Gas pipework could leak as a consequence of building works.
- Escaping gas could enter the fabric of the building including cavities and voids which is very dangerous and could lead to ignition or explosion
- Any leak in confined spaces or voids may be undetected by smell

The following is a comprehensive process that outlines how Cadent identifies service encroachments.

Chapter 3.12.2 – Process

1 – Identification

There are various ways a compromised service can be identified, examples of these are listed below:

- Meter work/readings
- Repair activity
- Mains replacement
- Plant protection visits
- Downstream work

- Land services work
- Desktop usage of maps
- Interference damage

2 – Survey and Investigation on site

In all cases, when an encroached asset is brought to the attention of Cadent, an initial visit job is raised for completion by the emergency call centre.

Upon attendance to the initial visit the engineer undertakes a full leakage survey of the area to confirm if there is any leakage from the encroached service.

If a service is deemed immediately unsafe based upon the visual inspection it will be escalated to be cut off by operations. Under the Section 10 of the Gas Act 1986, we are not required to maintain the connection of any premises if circumstances exist which would or might involve danger to the public. In this scenario, we demonstrate that we have taken all such reasonable steps prevent the circumstances from occurring and to prevent them from having that effect (i.e., investigation and attempting to resolve) before progressing with a service cut off at the main.

2.1 – Site Survey

The Encroached Asset Team handles the 'Site Survey Form', an essential document for assessing compliance in cases where services have been infringed upon. This form and a guidance document for reference are utilised during surveys to ensure thorough and standardised assessments.

If it's not possible to complete the checklist during the initial visit, a subsequent appointment is scheduled to gather all necessary information.

In instances where a service is found to be non-compliant, the Operations Surveyor will work to negotiate an alteration, as outlined in the survey form. Any agreements reached are formally recorded on the customer consent form.

After completing the site survey, the surveyor will provide the customer with a copy of this consent form, along with relevant informational materials. The customer will also be informed about the survey results and advised on the forthcoming steps in the process.

2.2 – Operational monitoring

For all encroached services greater than or equal to 63mm/2” and/or operating at pressures > 75mbar operational monitoring is required to confirm the integrity and stability of the pipe that has been encroached to ensure that no leakage is present.

This is completed by undertaking a leakage survey using a PPM gas detection instrument.

The time between leakage surveys on encroached services is no more than 28 days and is undertaken until the encroachment situation is resolved. Where access to the property has been obtained, surveys of the area in which the service is located are undertaken, paying particular attention to all possible ingress points, along with high and low-level checks.

3 – Case initiation

When a survey cannot be conducted immediately at the point of encroachment identification, the Encroached Asset Team is responsible for organising a follow-up survey. A notification letter is sent to arrange a date for the survey.

3.1 – Non-Responders

If customers do not respond to the Notification Letter within 14 days, the Encroached Asset Team will try contacting them by phone three times at different times. If contact is made, a survey is scheduled, and a survey confirmation letter is sent. If contact is not made with the customer, various warrant letters are sent and in a worst-case scenario it will be escalated legally.

3.2 - Completed Surveys

Once notification is received that an encroached service has been surveyed a case should be created by the encroached asset team in the system. If the survey has identified the installation as non-compliant, resolution in accordance with section **4 - Resolution** is required.

4 – Resolution

All identified non-compliant encroached services operating within Cadent's network are rectified through service alteration/relay or service cut off outlined in chapter 3.7.1.

If the gas service pipe or meter location are compromised because of the works, we sometimes may need to reposition the meter as close as is practical to the front face of the house, connecting back into the internal pipework. If the alteration works are undertaken at the time of the building works it will save time, disruption, and further cost.

4.1 – Cost Recovery

In cases where cost recovery from consumers is possible and represents the most economic and efficient approach, we pursue this option. For recovery to be possible, Under the Gas Act 1986, Cadent must be able to prove that the work

was made necessary by “any intentional act or culpable negligence of the consumer”. The Gas Act prevents us recovering our costs where the encroachment occurred before the current customer moved in or indeed where the work was done by a landlord who is not the customer. Even if we overcome this, the legal costs associated with taking consumers who refuse to pay to court are significantly higher than an alteration or relay and therefore in most cases is not the most efficient option.

4.2 – Chargeable service alteration

When work is deemed chargeable, the Encroached Asset Team calculates the cost based on standard or non-standard alteration cost tables. If the customer is reachable by phone, the team discusses the charge. Immediate payment can be processed over the phone; otherwise, payment plans are coordinated with the Debt to Cash team.

Consumers can provide their downstream pipework, agreed upon during the survey. All service pipework alterations comply with Cadent's procedures.

4.3 – Non chargeable service alteration

If, following the checks undertaken by the encroached asset team, it is identified that the works are non-chargeable the encroached asset team will attempt to contact the customer by phone to discuss booking in the remedial works with Operations.

As the job is non-chargeable Cadent will provide the downstream pipework from the new meter position to an appropriate and agreed tie in point on the customers internal pipework system.

The service pipework alteration is undertaken in accordance with Cadent’s service laying procedures.

Chapter 3.12.3 – Cost information

Within this investment case, there is only one type of work – the alteration or relay of gas services pipes that are not chargeable to consumers.

The nature of non-chargeable service relay/alteration is that they are reactive and driven by the actions of customers. It is, therefore, difficult to accurately predict the volumes and complexity of work required in future years. Service alterations and relays ensure a continued, resilient service to our customers whilst giving us certainty that the pipe is in the right location and that risks are remediated.

We are proposing to use information on the workload and costs of completed work in RIIO-GD2 to date as the basis for our forecast for the remainder of RIIO-GD2. We consider this to be a reasonable, representative, basis for the forecast at a programme level.

The average workload from years 1 to 3 of RIIO-GD2 as the basis for forecast

This approach would see us use the average cost and volume of remediations carried out in years 2021/22 to January 2024 to forecast the cost and volumes for the remainder of RIIO-GD2. While this method is standard for forecasting, we anticipate a potential decrease in projected volumes. This is due to our ongoing confirmation surveys and identification processes, which may reveal that some cases are not actual encroachments. Despite this, we are confident that this approach provides a solid foundation for our forecasts and is our preferred method.

	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Eastern						
North London						
North West						
West Midlands						
Total						

Figure 73 – Total Encroached Service Volumes tab in Appendix 1 – Diversions Re-Opener Finance Tracker

Figure 73 contains the volumes of completed remediations from years 2021/22 to January 2024 with an assumption for the workload remaining for year 2023/24 based on each network's pattern of monthly remediations. For years 2024/25 and 2025/26 we have used the average of the first three years of the price control as the basis for the forecast.

Figure 74 – Encroached Services Costs tab in Appendix 1 – Diversions Re-Opener Finance Tracker (18/19 prices)

Figure 74 contains the total cost for each year of the price control per network. This work is delivered by Cadent Direct Labour in all networks and in addition contractors were used in the North West and West Midlands to help with additional workloads. Below is a breakdown of the unit costs for Cadent Direct Labour and the Contractors used.

Cadent Direct Labour:

This unit cost is derived by taking all associated costs relating to an encroached service relay or alteration and dividing them by workload which yields the following unit cost by network. We have used our unit rates from 2023/24 as the baseline as it provides the most representative cost based on the most up to date cost

information. This can be found in the "**Services DLO Unit Rate**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker**.

Figure 75 – Baseline Unit Rate based on 2023/24 costs

	Eastern	North London	North West	West Midlands
2021/22				
2022/23				
2023/24				
2024/25				
2025/26				

Figure 76 – DLO unit rate in nominal prices – referenced in "Services DLO Unit Rate tab" in Appendix 1 – Diversions Re-Opener Finance Tracker

Contractors

[Security Data]:

This unit cost is derived from taking the total cost of the purchase order associated with the spend from the contractor and dividing it by the volume delivered.

	2022/23	2023/24
Labour		
Reinstatement		
Total		

Figure 77** – [Security Data] **unit rate referenced in** ["Security Data] **Contractor Unit Rates tab" in Appendix 1 – Diversions Re-Opener Finance Tracker

[Security Data]:

In September of 2023, [Sensitive Data] (previous contractor) left the contract, so we switched contractors to [Sensitive Data] As this work is currently ongoing and we don't have a final cost yet, we have derived a unit rate by taking the average of unit rate of years 2 and 3 for [Sensitive Data] shown in the table above.

	2023/23
Labour	
Reinstatement	
Total	

Figure 78a** [Security Data] **unit rate referenced in "**[Security Data] **Contractor Unit Rates tab" in Appendix 1 – Diversions Re-Opener Finance Tracker

[Security Data]:

The unit cost is derived from taking the cost the total cost of the purchase order associated with the spend from the contractor and dividing it by the volume delivered.

	2021/22	2022/23
Labour		
Reinstatement		
Total		

Figure 78b** [Security Data] **unit rate referenced in "**[Security Data] **Contractor Unit Rates tab" in Appendix 1 – Diversions Re-Opener Finance Tracker

Chapter 4.0
Adverse environmental factors

This chapter provides information for two projects impacted by adverse environmental factors.

- Chapter 4.1 – [Security Data]
- Chapter 4.2 – [Security Data]

Chapter 4.1 – [Security Data]

Chapter 4.1.1 Problem Statement and Needs Case

Introduction

Cadent own and operate the 300mm diameter [Security Data] which is located within [Security Data]. The embankment's crest is bituminous-surfaced and carries a single carriageway road used by private users and pedestrians.

The embankment has a long history of settlement and a series of investigations, monitoring and remedial works have been carried out by the canal owner in the past to retain the integrity of the canal structure. The pipeline also has a history of leakages linked to Stress Corrosion Cracking (SCC) and therefore any effects of future settlement pose a threat to the pipeline's integrity. The pipeline suffered 5 leak failures between 1975 and 1979. Investigations at the time suggested the cause was SCC linked to the operation of reformer gas in the pipeline between 1973 and 1975.

The settlement appears to be linked to an increase in heavy road traffic use. Leakage has occurred at a number of locations, and this may have contributed to further deterioration, stability problems and settlement of the embankment. In addition, movement of large trees may loosen the structure whilst root decay could provide drainage paths.

The following summary below provides an overview of key reports from 2008 to 2019 that have significantly impacted our decision-making process. It includes detailed evidence about the environmental damage caused to the pipeline and highlights the primary factors influencing our decision to propose a diversion as a remediation to protect the pipeline and maintain security of supply.

Summary of Reports

Cadent (formerly National Grid Gas Distribution) commissioned Residual stress measurements (RSM) at two locations (170m and 570m) on the pipeline in 2008 to determine the actual stresses within the pipeline. Direct measurements of stress were undertaken using the centre hole residual stress measurement technique. The results indicated sag bending due to the differential settlement of the embankment and confirmed that elevated stress levels are present in the pipeline and that these were likely linked to the embankment settlement. At the time there was no indication of large-scale instability and therefore the option taken to remediate the pipeline was to inspect and maintain at lower cost compared with other options considered. Vibrating wire strain gauges were subsequently installed to monitor the stress changes of the pipeline at the two locations. For further information refer to **Appendix 8 – [Security Data] 2008 report**.

In 2011 a detailed analysis of the strain gauge readings was conducted. The data suggested the stresses on the pipe were neither significantly increasing nor decreasing and were at similar stress ranges as noted post strain gauge installation. From approximately 3 years of strain gauge data, a seasonal effect started to emerge: with maximum tensile stress in the winter months (February/March) and maximum compressive stress in the summer months (July), due to contraction and expansion of the pipeline respectively. It was noted that, unless there are significant increases in the stresses over the next 12 months, which could be caused by the ongoing embankment settlement or other external factors, the pipeline is considered safe to operate. Monitoring of the strain gauges was continued. For further information refer to **Appendix 9 – [Security Data] 2011 RSM Report.**

In 2016 another study was carried out on the strain gauge readings. The basis of this monitoring was to measure the changes in strain in the pipeline, which can then be converted into an equivalent stress and compared to performance acceptance limits. Changes in pipeline stress indicate that additional ground settlements or movements occurred, due to the presence of the embankment structure, change in water table, etc. Site survey and observations indicated that there are visual indications of continuing settlement on the site. This would have potential effects on the pipeline that could be detrimental to its integrity. The stresses in the pipeline were likely to be cyclical and showed seasonal variations. Stress changes of approximately 20 to 24 N/mm2 were observed between annual maxima and minima which increased from 2008 to 2016. The reason for this behaviour was due to temperature variations, pressure variations and ground movement due to subsidence, change in water table and/or differential movement in the underlying soft marine.

It was recommended that further strain data should be collected for understanding pipeline behaviour and controlling short- or long-term measures for risk of pipeline failure. It was also recommended to collect quarterly strain data in order to assess the short-term risks associated with the pipeline. A soil/pipe interaction analysis was recommended. In order to do this analysis, a ground survey data including settlement profile that was taken in the last 2 to 3 years would be required and if

none is available a settlement survey would need to be undertaken. This would predict pipeline sections that will be experiencing higher stresses and hence necessary procedures for immediate action can be put in place. The full report can be found in **Appendix 10 – [Security Data] 2016 report**.

In 2017 further analysis of the strain gauge readings was conducted. Measurements were taken from the strain gauges at chainage 170 m and 570 m in January and April 2017 and are shown in Figure 79 and Figure 80. The predicted stress values for the 2016 strain gauge readings and previous estimated stresses from 2008 to 2011 are provided in figure 79. The full report can be found in **Appendix 11 – [Security Data] 2017 report**.

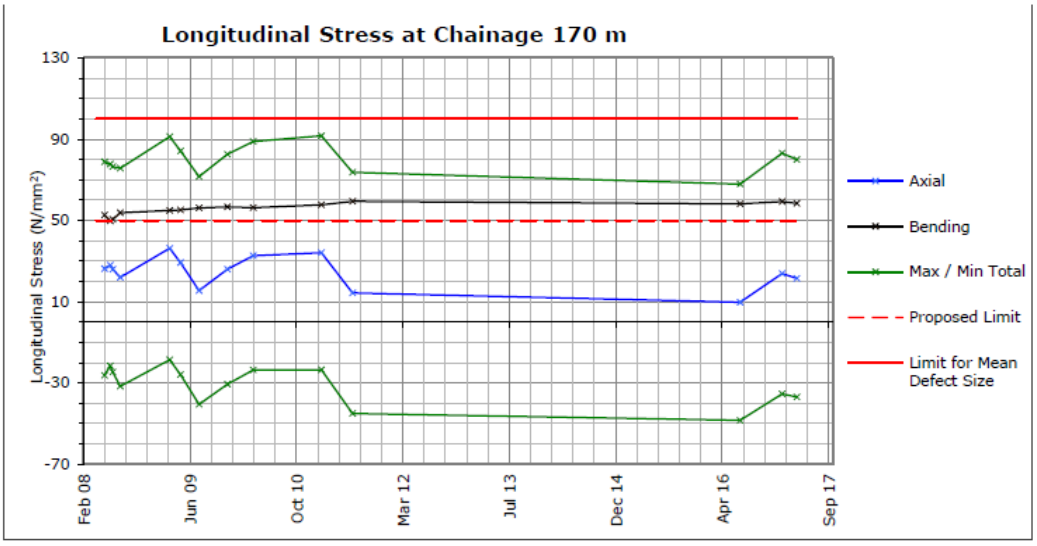

Figure 79 – 170m longitudinal Stress

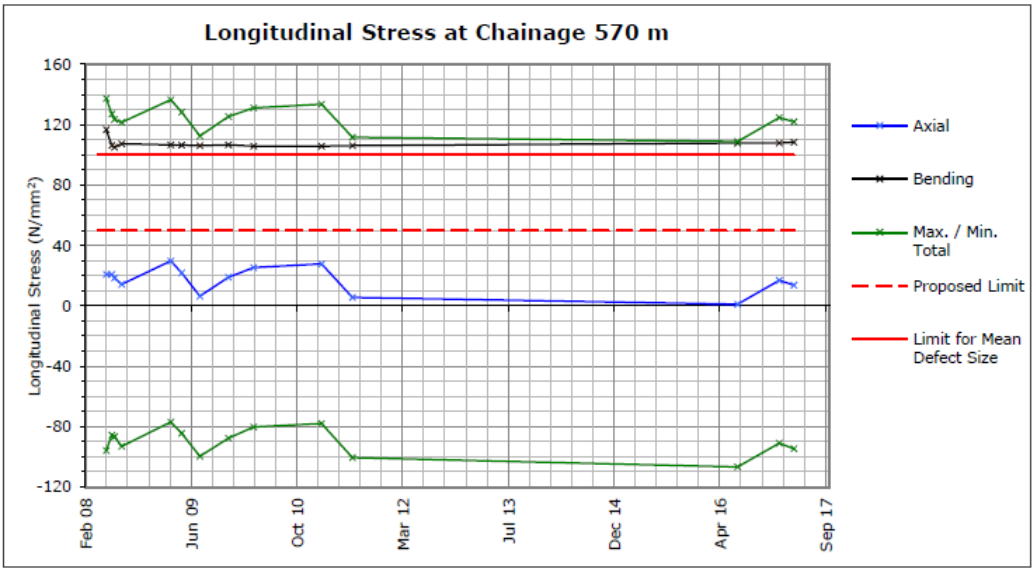

Figure 80 – 570m longitudinal Stress

The readings from Q1 2017 indicated similar cyclic patterns in strain readings as those observed before 2017. These patterns, possibly caused by changes in operating pressure, temperature, and seasonal fluctuations, show that pipeline stresses in Q1 2017 are comparable to those recorded between 2008 and 2011. This suggests the pipeline's operating condition in Q1 2017 is akin to that in the same period in previous years.

Notably, the stress levels were expected to decrease in summer and increase in winter, as reflected in current strain gauge readings. However, the Q1 stress reduction rate was lower than in previous years, necessitating further monitoring to determine if this is due to operational changes or ground movement.

At two specific locations (chainages 170 m and 570 m), longitudinal tensile stresses exceed the proposed limit of 50 N/mm2 that was derived using fracture mechanics and exceed the P/18 limit of 53 N/mm2 though they are lower than past maximums recorded between 2008 and 2011. While there's a decrease in local stress maxima and minima, there is a slight increase in bending stresses, indicating possible ongoing ground subsidence. The cyclic nature of axial stress points to seasonal influences.

Despite the stress at these locations being lower than in the past, this doesn't necessarily apply to the entire pipeline. The unknown deformed shape and longitudinal stress profile of the pipeline called for a comprehensive pipe stress analysis.

It was recommended that we continue quarterly strain monitoring. Although quarterly was cost effective, a monthly strain measurement provided a better understanding of the pipeline behaviour and settlement that can help manage the risk to the pipeline integrity.

For a thorough understanding of the ground conditions affecting the pipeline, a site-specific Ground Investigation (GI) was recommended. This would involve examining the ground strata and soil parameters, installing settlement monitoring devices, and comparing the findings with previous 2007 data.

The results from the GI would then inform a Soil/Pipeline Interaction Analysis (SPIA) to identify highly stressed or deformed pipeline areas not covered by existing monitors. The insights from SPIA would guide the pipeline's management plan, including potential locations for additional strain gauges and repair strategies, like using sleeves, to manage pipeline integrity risks before considering any diversion.

Investment Driver

Based on recommendations from the 2016 and 2017 reports we carried out a Geotechnical Investigation and a soil/pipeline interaction analysis. For more detailed information please refer to **Appendix 12 – [Security Data] Geotechnical Report** and **Appendix 13 – [Security Data] Soil – Pipeline Interaction Analysis**. The following conclusions were drawn from both reports:

- The current pipeline displacement profile is a function of two forms of ground movement, which are inducing bending stresses on the pipeline: subsidence along the embankment length and localised slope instability at discrete locations along the embankment.
- Based on the available pipe level data the axial stresses in the pipeline have exceeded the upper bound 100 N/mm2 performance acceptance criteria determined within the previous 2008 works.
- The stresses within the pipeline will increase should further movement of the embankment occur in the future.
- The section of the pipeline within the embankment needs to be diverted or remediation works undertaken to mitigate the current and future risks to the pipeline.

Based upon the analysis and discussions presented within the report, the following recommendations were provided:

- Remediation or diversion of the pipeline should be undertaken to reduce the risk from stress corrosion cracking and extend asset life.
- Regular ground movement surveys should be undertaken at least annually to capture any ongoing settlement of the embankment, until remediation or diversion of the pipeline is completed. The position of the pipeline should be included within these surveys.
- Dialogue should be maintained with the embankment owner / maintainer to ensure that any works undertaken are captured and that any developments that could suggest the pipeline's integrity is at risk are known.
- Consideration of the bends at the canal crossing needs to be made. The bends should be inspected (potentially through the use of residual stress measurements) as part of any further asset life extension preparations.

Chapter 4.1.2: Option Selection

When considering the current stress condition of the pipeline, a number of engineering solutions have been considered and the following are discussed within this section. For further detail please refer to **Appendix 14 – [Security Data] Optioneering Report:**

- Do Nothing – leave pipeline and embankment in its current state and continue to monitor.
- Pipeline remediation – inspect all welds and fit epoxy repair sleeves where required.
- Embankment remediation – review the stability of the embankment, remediate where necessary and undertake selective inspection and epoxy repair.
- Pipeline diversion outside of the embankment.

Option 1 – Do Nothing (discounted)

Ongoing monitoring of the pipeline with no remediation is not an option that should be considered in the long term. Based on the previous weld inspections undertaken in 2008, 50% of the welds that were inspected had evidence of stress corrosion cracking (SCC). It cannot be directly inferred that this proportion would be replicated along the rest of the pipeline and could me more or less than 50%.

Although it is noted that there have not been any additional failures on this pipeline since the previous repairs, the potential for ongoing ground movements would subject the pipeline and its welds to stresses not previously encountered.

The predicted longitudinal stresses and the latest strain gauge readings taken in March 2018 suggest that the pipeline continues to exceed the previously established limits for longitudinal stress, which will increase with further ground movements and thus increase the potential risk of loss of containment.

Enabling Works Required

Minimal enabling works would be required. An update of the monitoring equipment to allow real time monitoring would be recommended as a minimum.

Residual Hazards

The following residual hazards would remain for this option:

- The pipeline would remain within the existing easement in the embankment, which may result in access issues in the future.
- The condition of any welds subjected to SCC is unknown and therefore their capacity to accommodate any increase in stress due to settlement cannot be relied upon.
- The pipeline will still be subjected to regular surface loading from vehicles.
- There is a lack of knowledge relating to the condition of the pipeline bends at the canal crossing, and these would need to be investigated. There is the possibility that the stresses at this location would become unacceptable due to ongoing movements, if not already.
- The condition of the pipeline underneath the canal is unknown.

Cost / Benefit

This option would have the lowest capital cost as there are minimal works to be undertaken. However, there would be ongoing monitoring costs and there is also the risk that compensation or remediation costs would become apparent should another leak be detected on the pipeline. This option would have a high number of residual hazards and associated risk to manage.

Option 2 - Existing Pipeline Remediation (discounted)

Remediation of the pipeline through the use of inspection and epoxy shelling, whether undertaken as one, or multiple work phases would increase the resilience of the pipeline. The limitations due to SCC around the welds would be mitigated, such that the membrane stress would become the limiting factor. This would allow the straight section of pipeline within the embankment to accommodate higher levels of settlement in the future.

Enabling Works Required

All welds would need to be inspected in order to ensure the resilience of the pipeline. Depending on the outcome of those inspections, a number of welds would require epoxy shells. As mentioned within **Option 1**, 50% of the welds that were inspected during the 2008 works had evidence of stress corrosion cracking (SCC) and required epoxy shells to be installed. This ratio may not be strictly applicable to the rest of the pipeline, as there could be more or less than 50% of the total welds in this section requiring epoxy shells.

The stress condition of the welds at the bend by the canal crossing will need to be determined to ensure that utilising the existing canal crossing would not compromise the safe operation of the pipeline. This would include inspection as above and undertaking residual stress measurement (RSM) on the adjacent straight / unbent section of pipe.

Limitations

This approach would be subjected to agreement with the embankment owner as well as working with local stakeholders due to access requirements on the road.

There are also a large number of welds that would require inspection and potentially repair; when considering the chainage between the railway bridge and the canal crossing, there would be circa 70 No. welds (minus those already done in 2008). This may result in a large lead time for epoxy shells and sub-contractors to undertake the inspections and installation. The feasibility of this option would also be dependent on the outcome of these investigations at the canal bends.

Residual Hazards

The following residual hazards would remain for this option:

- The pipeline would remain within the easement in the embankment, which may result in access issues in the future.
- The pipeline will still be subjected to regular surface loading from vehicles.
- A large number of excavations along the embankment to facilitate the works would raise temporary works hazards and could lead to additional instability of the embankment in the future.

- As the ongoing stability of the embankment could not be guaranteed, the unknown condition of the pipeline bends at the canal crossing would need to be investigated. Any issues at this location would be harder to mitigate.
- The condition of the pipeline underneath the canal is unknown.

Cost / Benefit

This option would have a higher capital cost in order to cover the excavations, inspection, manufacture, and installation of the epoxy shells, although the cost of remediating all welds is less than the cost of diversion over this section length. Additional costs would be required to investigate and establish the condition of the bends at the canal crossing. This option would retain some level of operational risk as the pipeline is still within the embankment and any stresses at the canal bends would be retained. Ongoing ground movement monitoring would be required to capture future unexpected ground movement events.

Option 3 – Embankment Remediation (discounted)

A review of the stability of the embankment could be undertaken with remediation necessary to stabilise and minimise / prevent potential future settlement issues. This would control the increase in bending stresses in the pipeline. Ongoing monitoring of the embankment would be recommended in order to capture any unforeseen movements or events.

This option is dependent on any future mechanism of ground movement, such as slope instability, or washout of materials caused by canal leaks, and whether it can be controlled. There will remain a risk from third party interaction with the embankment, such as ongoing repair works to the road surface and road surface loading from vehicles. The condition of lining inside the bank of the canal is also important, in order to prevent any leaks through the embankment (as has happened previously), which could cause localised ground softening and slip movements.

Enabling Works Required

Agreement would need to be established with the embankment owner as well as with any governing bodies due to land sensitivity issues that may result in perimetry being required.

Cutting back of vegetation on the embankment to allow for access, which will include removal of mature trees such that further survey works can be undertaken to obtain a more detailed profile of the embankment and cross-sectional information.

Undertake detailed ground investigations to provide geotechnical parameters to be used to carry out a stability and settlement risk assessment of the embankment, as well as to feed into the design information for remedial works.

Undertake an assessment to determine the maximum allowable vehicle weight that should be allowed on the towpath during the works as trafficking by heavy vehicles may result in further ground movement.

The condition of the welds at the bend by the canal crossing will need to be determined to ensure that utilising the existing canal crossing would not compromise the safe operation of the pipeline. This would include inspection and undertaking residual stress measurement (RSM).

Limitations

This approach would be subjected to agreement with the embankment owner as well as working with local stakeholders due to access requirements on the road. There may be contractual issues regarding ownership of responsibility / duty of care when it comes to undertaking the physical works on site.

The feasibility of this option would also be dependent on the outcome of the investigations at the canal bends.

Residual Hazards

The following residual hazards would remain for this option:

- The pipeline would remain within the easement in the embankment, which may result in access issues in the future.
- The condition of any welds subjected to SCC is unknown (unless repaired) and the pipeline will still be subjected to regular surface loading from vehicles.
- There is an unknown risk around the condition of the pipeline bends at the canal crossing, and these would need to be investigated. There is the possibility that the stresses at this location would become unacceptable due to ongoing movements, if not already.
- The condition of the pipeline underneath the canal is unknown.

Cost / Benefit

This option requires a reasonable lead time for works to enable a slope stability analysis and before any necessary remediation works can be undertaken, in order to commence the enabling works.

The overall costs for embankment remediation would be low in comparison to a pipeline diversion. The details of the remediation and final cost would be dependent on the slope stability analyses.

Remediation of the embankment would not prevent any issues caused by third party interaction.

Option 4 – Pipeline Diversion

Routes

Diversion Route 1 (Discounted)

Diversion Route 1 is shown on Figure 81

Figure 81 – Route 1

This route utilises the existing canal crossing and the eastern tie in is just beyond the existing sheet pile cap by the crossing bends. The pipeline is then diverted down the embankment and into the adjacent field on the northern side of the canal. The western tie in is at the AGI.

Enabling Works Required

As identified within the SPIA analysis above, the pipeline at the existing canal crossing has unknown stresses within the bends. The bends would need to be investigated and RSM undertaken at this location. Due to the proposed stoppling and bypass activities in this area, the area of investigation (and potentially RSM) would need to be extended in order to cover the area of pipeline to be exposed as part of the works. This is due to the potential for bending stresses within the straight section of pipeline due to the embankment settlements.

Limitations

This approach would be subjected to agreement with the field and embankment owners, as well as working with local stakeholders due to access requirements on the road. Depending on the proposed method of working, access for equipment to

undertake the stoppling activities may not be possible due to weight restrictions on the embankment, as well as the surface loading limitations of the pipeline, both of which would need to be confirmed. The feasibility of this option would also be dependent on the outcome of the investigations at the canal bends.

The weight of proposed stoppling equipment as well as the excavations as part of the stoppling and weld inspections would require bank stabilisation works to be undertaken prior to commencing the main works. Access to the working area may also be limited due to the weight of stoppling equipment and materials and the effect on the rest of the embankment, which would need to be confirmed. Easements within the field and underneath the railway boundary would need to be agreed. The drain underneath the railway bridge may need diverting during works due to limited space.

Residual Hazards

The following residual hazards should be considered for Route 1:

- The pipeline would remain within the easement in the embankment, which may result in access issues in the future.
- The pipeline will still be subjected to regular surface loading from vehicles when in the embankment.
- The condition of the pipeline underneath the canal is unknown.
- P/18 and SCC considerations during stoppling.

Cost / Benefit

Of the three route options, Route 1 potentially has the lowest capital costs as no new canal crossings will need to be installed as part of the diversion. There may be additional costs relating to excavation, inspection of the section by the canal crossing, manufacture, and installation of the epoxy shells (if required). This option would retain some level of operational risk as the pipeline is still within part of the embankment and any stresses at the canal bends would be retained.

Diversion Route 2 (Discounted)

Figure 82– Route 2

This would be a completely new route that includes a new canal crossing adjacent to the AGI, followed by routing the new pipeline beneath one of the main roads towards the western boundary of the [Sensitive Data] complex. Consideration must be made to the section of pipeline adjacent to the southern bank of the canal crossing, as this will need to be capped so that the southern section of pipeline can remain live in order to maintain the supply to [Sensitive Data,] whilst abandoning the crossing. This would possibly involve an additional set of stoppling activities between the [Sensitive Data] and the canal.

Enabling Works Required

Route 2 would require a more in-depth stakeholder engagement plan, due to the potential access and environmental concerns that would arise. Liaison with local highways and acquisition of permits under NRSWA to undertake the works would be required.

It should be noted that there have been recent site developments on the south side of the canal embankment at the proposed location of the crossing launch / reception pits. Due to these developments, additional landowner engagement would be required and would likely result in an additional feasibility study to be undertaken in order to find a new crossing location.

Additional investigations will be required to determine the ground conditions at the proposed locations of the “no dig” crossing, to inform the selection of the preferred method of trenchless construction.

Limitations

As mentioned within the enabling works, the access on the south side of the canal for the canal crossing is limited and the original location for the launch / reception pit is potentially no longer viable. Therefore, an alternative crossing location will need to be found. This will prove challenging due to the level of development on the south canal bank.

Construction of the pipeline within the road may also be difficult due to the access requirements of local population and businesses.

Testing of the newly completed section of pipeline needs to be considered. [Sensitive Data] found, an exclusion zone of 100m is required during hydrotesting. Due to the proximity of normally occupied buildings, this may not be viable, and an alternative method of testing may need to be considered. Supply to [Sensitive Data] will need to be maintained. The offtake for the site is situated near to the south side of the canal. Therefore, an additional stoppling exercise will need to be undertaken in order to maintain the supply.

Residual Hazards

The following residual hazards should be considered for Route 2:

- The new pipeline route would be underneath a main road, and as such will have a higher risk from third party interaction.
- Higher risk profile due to proximity to normally occupied buildings.
- P/18 and SCC considerations during stoppling.

Cost/Benefit

Route 2 is most likely to have the highest capital costs of any of the engineering options, due to the requirement of a new canal crossing and the diversion routing beneath a key road. In addition to the construction costs, there is the risk that additional compensation costs may be incurred due to the above works. Future access to the pipeline, although undertaken under NRSWA, would cause interference and may be a factor with stakeholders.

This route would require an additional stoppling exercise that would not be required within Route 1 or 3, due to [Sensitive Data] south of the canal. The stoppling exercise would be required to decommission the canal crossing and section of pipeline within the embankment, whilst keeping [Sensitive Data] operational.

This route does, however, remove the requirements of the embankment and the existing canal crossing and as such remove this hazard. This is of course offset by the increased risk from third party interactions within the road under which the pipeline would be routed.

Diversion Route 3 (Preferred)

Diversion Route 3 is shown on Figure 83.

Figure 83 – Route 3

Figure 84 – route 3

This route follows the similar path as Route 1; however, a new canal crossing would be constructed and the eastern tie in would be near to [Sensitive Data]. This diversion removes the pipeline completely from the north embankment and also eliminates the needs for any street works.

Enabling Works Required

For Route 3 the launch and reception pit locations for the canal crossing will need to be finalised. The location of [Sensitive Data] would need to be confirmed on the south side of the canal in order to ensure that the new tie-in location does not conflict with it, and that supply [Sensitive Data] can be maintained. Easements within the field and underneath the railway boundary would need to be agreed.

The drain underneath the railway bridge may need diverting during works due to limited space.

Additional investigations will be required to determine the ground conditions at the proposed locations of the “no dig” crossing, to advise on the preferred method of construction. Thorough surveys will be required to determine the dimensions of the canal (particularly depth and bed construction / lining) as part of the “no dig” profile.

Limitations

The positions of the launch and reception pit locations for the canal crossing will need to be finalised. Due to the possibility of flooding in the field to the north, these works would have to occur within the summer months.

Residual Hazards

The following residual hazards should be considered for Route 3:

- Open cut excavation within the field will need to be offset from the embankment and associated back drain to prevent the excavation from having a detrimental effect on the embankment stability.
- High water table may be present, requiring appropriate temporary works measures.
- P/18 and SCC considerations during stoppling.

Cost/Benefit

The costs for Route 3 are anticipated to be more than Route 1 – due to additional canal crossing construction, but less than Route 2 – as the diversion distance is shorter as well as any secondary costs.

However, Route 3 would not require the use of any section of the existing embankment or canal crossing and as such any unknowns associated with SCC in these areas would be mitigated.

This route also has the advantage that it would not be constructed within a road and access would be easier to manage as maintenance would not be subject to NRSWA and can be undertaken within the field (and not requiring works within the embankment).

Optioneering Matrix

A high-level optioneering matrix has been developed for the above engineering options, taking into consideration the outcomes from the current GIR and SPIA reports. This matrix has been developed using assumptions based upon engineering judgement and is considered a qualitative assessment only.

Within the matrix, a number of factors have been considered to which their importance is weighted. The weighting is from 1 - being considered least important, to 5 – being considered important / deciding factor. The factors considered for each option are:

- Technical - how well does the option resolve the issue of existing and future stress in the pipe.
- Constructability - how easy or simple is the option to build (including considerations relating to legal / easements)
- Maintenance - how much maintenance or ongoing monitoring / remedial works will be required following implementation of the option.
- Health and Safety - what construction hazards will be induced by the design.
- Sustainability - use of materials / efficiency of design.
- Cost – considers the perceived (qualitative) construction and material costs.
- Residual Risk - what hazards cannot be eliminated by the design and what hazards are induced by implementing that option.

For each option, a ranking is assumed against each of the factors, the ranking following the same format as above: 1 – being considered least applicable / low value, to 5 – being considered most applicable / highest benefit.

For each of the options, the factor weighting is multiplied by the assumed ranking to give an overall value. The sum of the overall values for each option are then compared in order to provide an overall order ranking for each option. This is shown within the table below.

Factor	Weight	Do Nothing		Pipe Remediation		Embankment Remediation		Route 1		Route 2		Route 3	
		R	W	R	W	R	W	R	W	R	W	R	W
Technical	5	1	5	3	15	3	15	4	20	5	25	5	25
Constructability	3	5	15	3	9	3	9	3	9	2	6	3	9
Maintenance	5	1	5	3	15	4	20	4	20	4	20	4	20
HSW	5	4	20	3	15	3	15	2	10	1	5	2	10
Sustainability	2	4	8	3	6	4	8	3	6	2	4	2	4
Cost	3	4	12	4	12	4	12	3	9	1	3	2	6
Residual	5	1	5	3	15	3	15	3	15	3	15	5	25
Overall Value			70		87		94		89		78		99
Order Ranking			**6**		**4**		**2**		**3**		**5**		**1**

R = Rank

W = Weighting

Figure 85** [Security Data] **Options Matrix

Chapter *4.1.3 – Preferred Option*

Preferred option Rationale – Option 3

Based upon the optioneering matrix and the discussions within the engineering options, undertaking a diversion is still considered the most appropriate method for reducing operational risk to the pipeline.

The matrix suggests that the embankment option is a close second. This is partly due to the perceived costs associated with the works required (such as repair of affected welds and the civils works to stabilise the bank), compared to those of Route 3 (stoppling, “no dig” canal crossing installation, open cut costs).

However, the residual risks of the embankment option are considered higher than for Route 3 as the pipeline will remain in the current stress state, which also relies on the condition of the bends at the canal crossing and the condition of the pipework underneath the canal. A new diversion would substitute this section and therefore remove the risk associated with these existing stresses.

Scope of work

Below is a summary of the scope of work which includes the following items:

- DN300 HP diversion approximately 900m in length. Route corridor has been defined as Option 3
- Hot Tap connection inside [Sensitive Data]
- Open cut crossing of [Sensitive Data].
- Open cut crossing under the [Sensitive Data] railway through an existing viaduct.
- Auger bore crossing of [Sensitive Data] and [Sensitive Data]
- Micro-tunnel crossing of [Sensitive Data]
- Hot Tap connection on the south side of [Security Data] canal c/w BISEP tool & Bypas [Sensitive Data]

Register of Assets Impacted

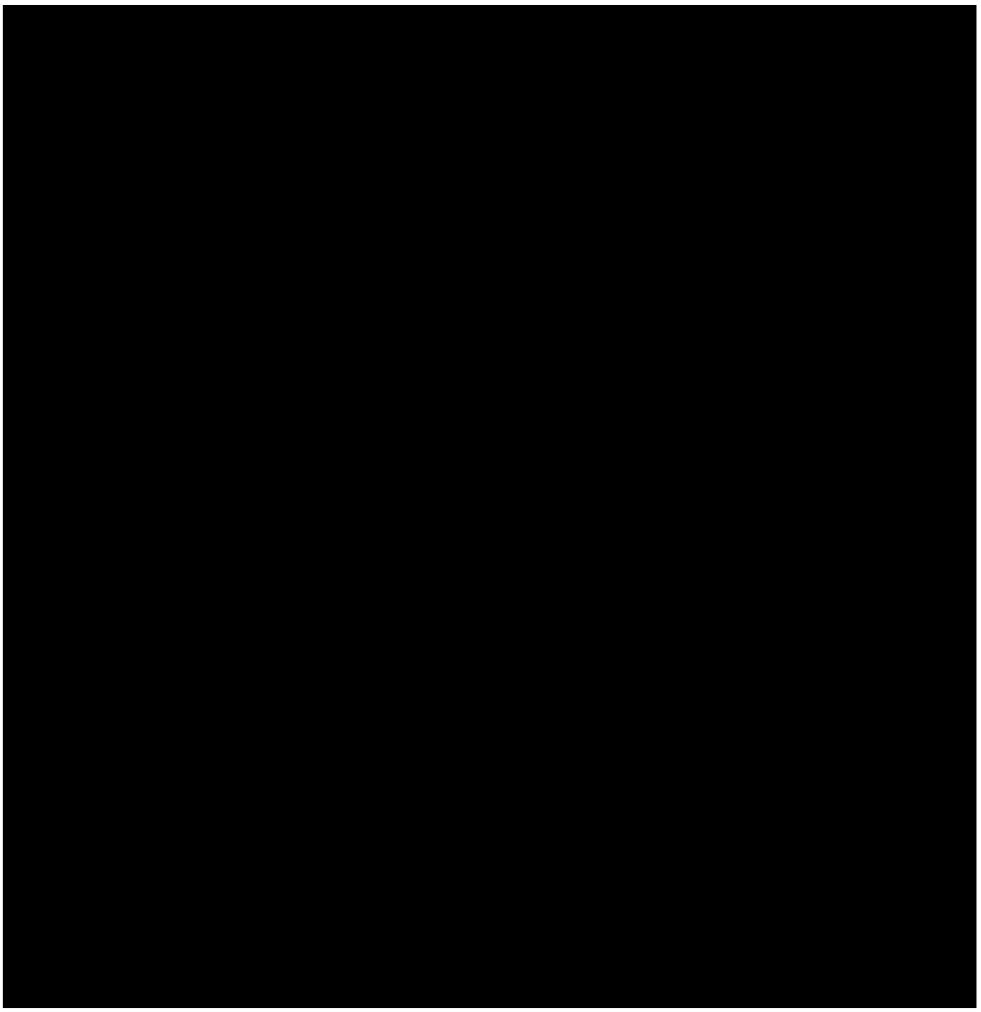

Figure 86 – [Security Data] Asset register

Supply and Demand Scenario Discussions and consumer benefit of the preferred option

The primary objective of the Project is the continued safe operation of the HPGP in order to maintain and secure the gas network and continue supply to parts of [Security Data] and the town of [Security Data] as well as gas supply in the long term. This is to be achieved through diverting the HPGP by installing 850 metres of steel pipe in parallel with the existing pipe, but outside of a canal embankment area affected by ground movement, prior to decommissioning the affected section. This is required because it is a single source of supply to [Security Data]. Furthermore, the whole of the [Security Data] (including the [Security Data])) being shut down would cause a loss of 64 district governors, 113 direct connections and circa 60,000 properties.

Key Milestones

- Project start end of June 2020 and Material Procurement October 2020
- Competitive tender exercise to award a contract for preferred design and consenting supplier(s) March 2021.
- Detailed Design complete in June 2021
- Ongoing land disputed from 2021 and expected to be resolved at the start of 2024
- Construction set to begin at the end of 2024
- Project completion date set for 2025

The following diagrams shows an outline Gantt chart of the activities ongoing, up to the end of the design stage.

Key Dates		29-Jun-20 A	22-May-25	1221d
A1270	Project Start	29-Jun-20 A		0d
A1280	Project Duration	29-Jun-20 A	22-May-25	1221d
A1400	Stage Gate 2 - Concept Design		29-Jun-20 A	0d
A1440	Stage Gate 1 - Feasibility Study		29-Jun-20 A	0d
A1410	Stage Gate 3 - Detailed Design		07-Jun-21 A	0d
A1420	Stage Gate 4 - Construction		13-Dec-24	0d
A1430	Stage Gate 5 - Handover & Closure		22-May-25	0d
A2060	Project Complete		22-May-25	0d

Figure 87 – [Security Data] Timeline

Figure 88 – [Security Data] Gantt chart

Chapter 4.1.4 – Stakeholder Engagement

Once it was confirmed that a diversion was required, [Third Party] (engineering consultancy) conducted a feasibility study which outlined a number of routes that could be progressed.

Diversion Route 1, as discussed in 'Chapter 4.1.2: Option Selection' would require the footpath to be closed for a significant period of time, which we were informed would cause issue for the landowners and general members of the public as this is a popular walking route.

Diversion Route 2 is a largely street works route which would require the highways to be closed or impacted for a large amount of time. Which was not favourable with the public due to being the main route in and out of the area. It was later discovered that a [Security Data] was due to be build opposite the AGI that we needed to connect back into, so would not be possible.

Diversion Route 3, this followed a similar route to Route 1 but would Directionally Drill under the footpath, therefore reducing the impact of the landowner [Security Data]) but also on the wider public who used this as a pedestrian route.

Route 3 was progressed under initial conversations with the Landowners on the Farm land to the north. These conversations were positive and gave us to most cost-efficient route at that time. However, since the project has developed, the land negotiations have been prolonged and in 2022/23 there was the unfortunate news that landowners of the 2 land parcels had passed away. This has left us requiring going through a Compulsory Purchase Order (CPO) to obtain the relevant permissions to carry out the project. This is progressing well, with 3 objections, one of which from [Security Data], who has since rescinded their objection after a town hall meeting, we held in November 2023. The other objections were from parties with an interest in the land parcels with the deceased parties, the points of objection have been settled with the parties and the objections are due to be lifted in Jan 24. This has increased the costs associated with this diversion project, but were unforeseen and unexpected, but had unfortunately pushed this project between years in the RIIO-GD2 price period and therefore increased the cost to deliver due to inflationary impacts and the cost of dealing with the CPO and negotiations.

Chapter 4.1.5 – Cost Information

The cost information below is based on actual costs incurred and a forecast methodology for the different aspects of the project. Refer to **"[Security Data] Costs tab**" in **Appendix 1 – Diversions Re-Opener Finance Tracker**

Figure 89 – Total adjustment for [Security Data] 18/19 Prices

Our cost forecast is split into different sections:

Project management:

Our cost estimate for years 2024/25 and 2025/26 is based on the different staff involved in delivering the project (integrity engineers, procurement etc) and estimating the hours worked on the project from engineering experience and multiplying it by a unit rate.

Land and Consents:

As mentioned in our stakeholder engagement chapter we had to carry out a compulsory purchase order on our planned diversion route. We were given a breakdown by our solicitors of the expected hours and the hourly rate for the different land and consents aspect of the project.

Construction cost estimate increase:

The project was originally procured through a competitive tender event in 2020 based on a forecast delivery year of 2021. which resulted in a price below market expectations for this project. As above, the project build date is now forecast for 2025. This has now had an impact on our pricing estimate.

Although our estimate is increasing, we believe this to be in line with increases in indices within the Construction industry. The below are some of the factors that have led to an impact on the increased cost estimate.

- Impact of higher construction costs over and above inflation
- Material market impact post COVID.
- Current Market forces including resources devoted to other major infrastructure projects e.g. HS2 & Hinckley point

For all the above reasons the increases applied are considered reasonable but the final cost will be subject to market testing post CPO process expected Q4 2024.

Chapter 4.2 – [Security Data]

Chapter 4.2.1 - Problem Statement and Needs Case

Five pipelines (operated by Cadent Gas Ltd) cross under the [Security Data]. The pipelines are listed below from north to south shown in figure 90 below.

- [Sensitive Data]
- [Sensitive Data]
- [Sensitive Data]
- [Sensitive Data]
- [Sensitive Data]

The pipelines were originally submerged beneath the bed of the [Security Data] as indicated below, with a varied rate of depths beneath the river bed from 0.15m to 4.88m ODN (Ordnance Datum Newlyn). This is shown in figure 91 below.

Figure 90 – 0.15 to 4.88

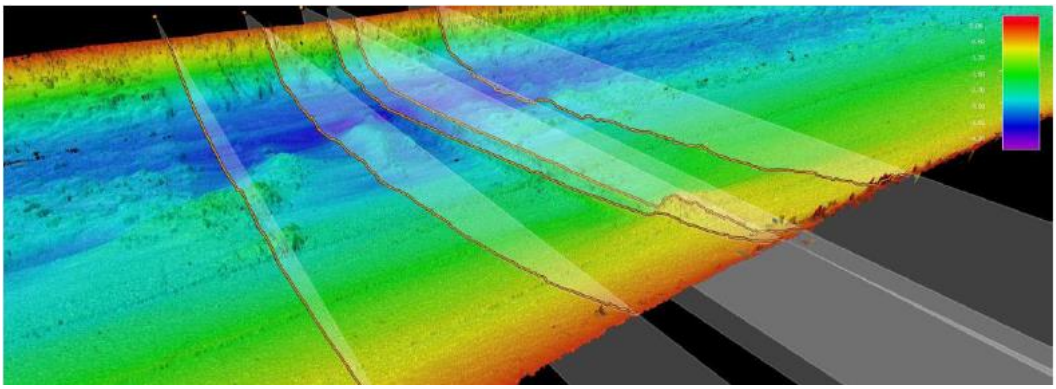

Figure 91 – Pipelines in the riverbed

Investment Driver

This part of the channel has been subject to vertical bed erosion over recent years. This has resulted in two of these pipelines being exposed shown in figure 92 below. Following a multi-beam echo sounder (MBES) survey, [Sensitive Data] and [Sensitive Data] were both shown to be exposed with some undercutting beginning to occur, confirmed by [Sensitive Data] engineering. A third pipeline [Sensitive Data] was also shown to be partially exposed. The area of the pipeline crossing is reported to have been subject to some erosion over recent years, with mid-river depths at around 2.0m in 2008, 2.8m in 2012, 3.5m in 2018 and 3.4m in 2020. As a result of recent hydrographic survey data, Cadent Gas instructed [Sensitive Data] to assess the risks associated with low cover upon the gas pipelines under the bed of the [Security Data] in way of [Security Data].

Figure 92 – Pipeline exposure

In addition, there was also concern with the volume of vessel traffic passing the site and the risk of reported stone/gravel barges resting upon the riverbed during low water damaging the gas pipelines. We were instructed by [Sensitive Data] to carry out a review of the risks associated with passing vessels making contact with the subject pipelines under the bed of the [Sensitive Data].

We were provided with bathymetric hydrographic survey report of the river section in way of the crossing gas pipelines together with supporting drawings of the originally buried gas pipelines from [Sensitive Data] engineering. The full [Sensitive Data] Report can be found appended **Appendix 15 – [Security Data] Report.**

Together with tide tables and interpolation of adjacent tidal gauges, the depths of the river were reviewed and calculated in way of the gas pipelines and derived the risk of commercial and leisure traffic utilising the river in way of the buried gas pipelines.

[Sensitive Data]

The [Sensitive Data] pipeline appears to be partially exposed from beneath the riverbed over an approximate length of 59.0m from the (East) deeper channel to the shallower (West) side of the riverbed, where we can also see the pipeline exposure of the [Sensitive Data] pipeline below

Figure 93 - Two pipelines exposed

[Sensitive Data]

The [Sensitive Data] pipeline also appears to be partially exposed from beneath the riverbed over an approximate length of 61.0m from the (East) deeper channel

Figure 94 – Three pipelines exposed

From review of the hydrographic data provided in **Appendix 16 – [Security Data] Report**, there appears to be exposure of previously buried pipelines, with [Sensitive Data] pipeline, [Sensitive Data] pipeline and [Sensitive Data] pipeline exposed over 7m, 59m and 61m respectively.

The majority of vessel traffic whether commercial or leisure tend to do most of their river passages around LW (Low Water), in order to avoid the low bridges along the length of the [Security Data]. We were advised by [Security Data] that the maximum permissible draft for a commercial and leisure vessel transiting the [Security Data] is 1.9m and 1.4m respectively.

There are two significant areas of the river in way of the uncovered gas pipelines, the deep channel to the East of the river and the shallows to the West, ranging in depths from -4.11m CD (Chart Datum) to -0.5m CD respectively.

Within the deeper channel of the river, it was noted that the lowest LW (Low Water) is -0.45m CD, which suggests that with a vessel draft of 1.9m, the keel would be at -2.35m CD during the lowest LW (Low Water). Similarly, a leisure vessel's keel with a maximum permissible draft of 1.4m would be at -1.85m CD whilst at the lowest LW.

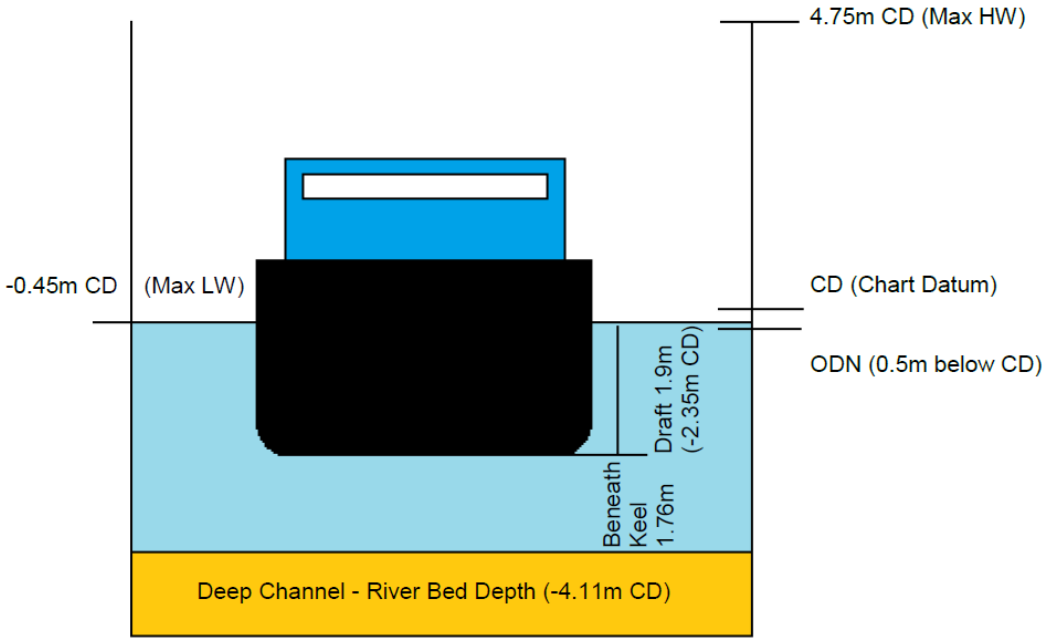

Figure 95 – Riverbed Depth

However, when considering shallower waters in way of the exposed gas pipelines at a depth of 2.0m / 1.8m ODN or shallower (-2.45 / -2.25m CD), it was noted that commercial vessels with a draft of 1.9m (-2.35m CD), could subject the pipelines to either movement as the vessel's keel passed only 100mm above the pipeline (-2.45m CD) or ground in way of -2.25m CD

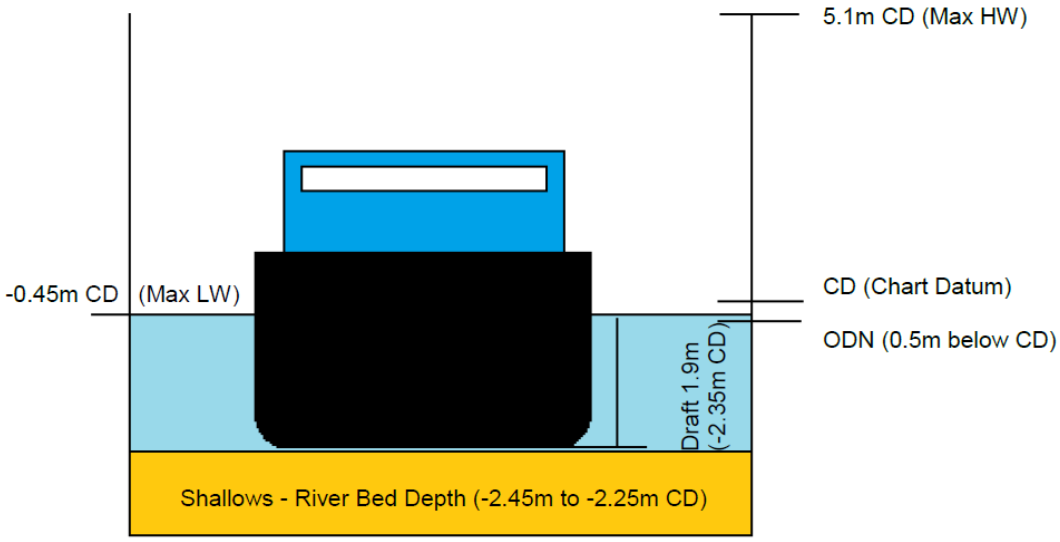

Figure 96 – Riverbed Depth

Nevertheless, whilst noting that the maximum permissible draft is 1.9m for commercial vessels, it was noted by users of the river that their vessels have been previously permitted to transit the [Security Data] with a (2.14m to 2.44m) draft, whereby there is considerable risk of grounding in way of the shallows at 2.59m CD and 2.89m CD respectfully, subjecting the gas pipelines in way to considerable potential contact damage

It was concluded that, with the maximum draft of the commercial and leisure vessels being 1.9m and 1.4m respectively, that there is a medium to high risk of a grounding event and making contact with the pipelines. Both commercial and leisure vessels tend to travel during low water conditions to help pass under the low bridges along the [Security Data]. At low water, within the deeper parts of the channel (centre and right-hand side) and with a permissible draft of 1.9m, there could be approximately 1.8m clearance between the keel and the bed. Within the shallower waters on the left-hand side, there could be as little as 100mm between the vessel's keel and the top of the pipelines, again assuming a draft of 1.9m. This means that the pipelines could be subjected to either movement or grounding in this scenario.

Chapter 4.2.2 – Options Considered

We have a responsibility to protect our asset. Therefore, the main objective of the works is to protect the pipelines and prevent further bed scour occurring in the future. A list of options has been identified and assessed based on an understanding of geomorphological process and engineering feasibility.

- **Option 1 – Do nothing** – No intervention.
- **Option 2 – Do minimum** – Ongoing monitoring (further MBES surveys)
- **Option 3 – Layered [Sensitive Data]** – Installation of [Sensitive Data] placed in several layers. Starting with a coarse gravel layer and culminating in rock armour. The gravel settles over the pipelines, providing protection as the larger rocks are positioned. The larger boulders would be sized to resist movement.
- **Option 4 – Pre-filled rock bags** – Rock bags are placed over the pipelines and then fixed to the riverbed by divers, if required by calculations.
- **Option 5 – Grout filled mattress** – Grout filled mattresses are placed over the pipes and fixed to the riverbed. These would set in situ once exposed to water.
- **Option 6 – Frond matting** – Mats with a dense array of polypropylene strips attached to a grid and anchored to the riverbed to encourage sedimentation and increase natural cover across the pipelines.
- **Option 7 – Re-route pipelines** to an alternative location or buried deeper.

An options matrix is provided below describing the options in more detail and considers potential benefits, opportunities and constraints and risks. The information presented at this stage is indicative and based on engineering judgement relative to the other options.

Options	Benefits and opportunities	Constraints and risks	Recommendations
Option 1 – Do nothing	• No capital expense	• Potential risk of further exposure(s), damage and rupture of pipeline. • Safety of navigation compromised.	Does not address the aims and objectives - do not proceed
Option 2 – Do minimum	• Minimal capital expense. • Opportunity to understand flow and sediment dynamics in greater detail allowing more targeted remediation in future.	• Potential risk of further exposure(s), damage and rupture of pipeline. • Safety of navigation compromised. • Additional work may still be required following monitoring.	Does not address the aims and objectives - do not proceed
Option 3 – Layered [redacted]	[redacted]	• Less secure protection as individual boulders can shift in high flows. • Risk of damage to pipes during construction, due to impacts from the deposition of the stone. This will depend on the construction method employed.	Likely to provide adequate protection to pipeline and minimal encroachment – proceed to consultation
Option 4 – Pre-filled rock bags	• Minimal vertical encroachment into water column (size assumed to be equivalent to rip-rap D50 of 200mm, comprising material 50-75mm), therefore less impact on flows and lower risk to navigation. • Increased design life when compared with [redacted] Primarily due to resistance to movement of the large bags.	• Divers potentially required to fix solution to riverbed. • Damage to bags following impacts (from vessels, anchors or debris) could reduce the life expectancy of solution as loose gavel could be washed away and requiring reinstatement.	Likely to provide adequate protection to pipeline and minimal encroachment – proceed to consultation

Figure 97 – Options matrix 1

Options	Benefits and opportunities	Constraints and risks	Recommendations
	• Individual bags have a limited scope to settle or shift to account for a shifting riverbed.	• Raises bed levels which may affect some vessel movements.	
Option 5 – Grout filled mattress	• Minimal vertical encroachment into water column (estimated 300mm from bed in total depending on design), therefore less impact on flows and lower risk to shipping. • Placed as flexible mattress, less risk of damage to pipeline. Lowered from a barge and fixed to the riverbed when in position. • Reduced risk of movement due to size of the mattress.	• Divers required to fix solution to riverbed. Resulting in construction risk and constraints on time available to dive due to tides. • Less flexibility following construction – potential of damage if undermined. • Difficult to repair. Large portions of the protection may need to be replaced, whereas areas can be topped up for options 3 and 4. • Raises bed levels which may affect some vessel movements, limit times when the reach is navigable or increase risk of grounding (particular in shallows).	Likely to provide adequate protection to pipeline and minimal encroachment; however, following initial enquiries supplies in the UK may be limited or unavailable – do not proceed
Option 6 – Frond matting	• Mimics natural vegetation and encourage rapid sediment deposition which prevents further erosion. • Established a more stable and deeper depth of cover of the pipeline. • Evidence it can activity support marine life providing sustainable alternative. • Potentially less intrusive into the water column overall.	• Some sediment deposition may affect vessel movements, limit times when the reach is navigable or increase risk of grounding (particular in shallows). • If a vessel does run aground on top of the frond matting it is unlikely to prevent damage to the pipelines.	Unlikely to adequately protect pipelines from damage if a vessel grounds – do not proceed
Option 7 – Re-route pipelines	• Can be positioned (vertically) to remove risk altogether (from exposure and/or impact from vessels) • Potential for significant extension to the design life of pipeline crossing. • No long-term impact to vessel movement.	• Significant capital expense. • Increased complexity of design and route planning. • Increased lead in time from conception to delivery.	Best all-round solution for navigation and the integrity of the pipeline in the long-term – proceed to consultation

Figure 98 – Options matrix 1

Chapter 4.2.3 – Preferred option

Preferred Option Rationale and Criteria for selection

Option 3 – Layered [Sensitive Data] (Preferred)

The preliminary options outlined above are further detailed in **Appendix 17 – [Security Data] Optioneering Report**. The report outlined a list of options. The decision to favour Option 3 – Layered [Sensitive Data] over re-routing the pipelines

(Option 7) was based on a multifaceted analysis. While re-routing offered a robust long-term solution, it was deemed less favourable due to its high capital costs, complex and time-consuming execution, significant environmental and social impacts, operational disruptions, and regulatory challenges. These factors rendered it impractical, particularly when considering the need to divert two high-pressure pipelines. Conversely, the Layered [Sensitive Data] method emerged as the preferred option due to its cost-effectiveness, quicker implementation, and minimal environmental impact. This approach, involving a strategic layering of gravel and rock armour, effectively protects against bed scour while ensuring operational continuity. Its feasibility, particularly in the challenging conditions of the [Security Data] at [Security Data], and the flexibility in its design to manage lateral erosion risks further cemented its suitability. The [Sensitive Data] solution is generally more acceptable to communities and stakeholders, given its lower disruption and proven effectiveness in similar scenarios. This holistic assessment, prioritising both technical efficacy and practical considerations, led to selecting the [Sensitive Data] method as the optimal approach for pipeline protection in this context.

Preferred Option description

A layer of gravel has been specified above the exposed pipe, extending at least 100 mm above the pipe crowns, to reduce the impact load on the pipes from the riprap as it is dropped into place during construction.

Figure 99 below shows a cross section of the proposed solution at [Sensitive Data], results carried from a survey carried out in April 2021 show this pipe was exposed for approximately 50m. From chainage 13m to 90m three layers of [Sensitive Data] have been specified to protect the exposed pipe in this scenario.

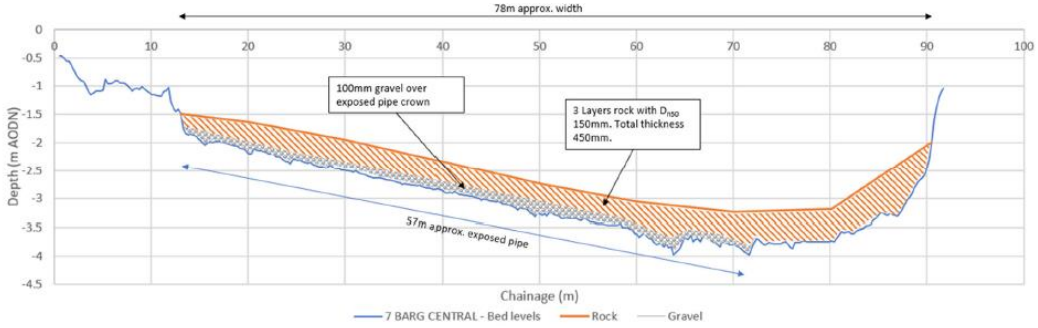

Figure 99 – Solution for [Sensitive Data]

It should be noted that the cross section in Figure 99 is based on a survey taken in April 2021, with little or no cover above the pipe for the majority of the channel width (approximately chainage. 15m to 72m). This would require three layers of [Sensitive Data] across much of the channel. In December 2022 considerable accretion had occurred with up to 700 mm of additional cover to the pipe found on the left side of the channel, whilst it remained exposed on the right. In this scenario, only a single layer of rock would be required from chainage. 9m to 25m then increasing to three layers by chainage 30 m. This scenario is shown in Figure 100 below. The variation in bed levels over time mean that the volume of material

required will be subject to the level of the bed at the start of the works and the total volume of material required will vary accordingly. It should be noted that only the two most exposed pipes, [Sensitive Data] and [Sensitive Data], closely follow the level of the riverbed and are subject to such a variation in cover requirements.

Figure 100 – chainage 9 to 25

Whilst the gravel layer is only proposed where pipelines are exposed, the full five pipes are proposed to be covered as can be seen in the long section shown in Figure 101 below. Covering only the two most exposed pipes was assessed as an option, however this could induce scour directly upstream and downstream of the protection, potentially inducing more scour and exposing the other pipes.

Figure 101 – 68 approx length

Summary

- Based on the requirement for three layers of 150mm [Sensitive Data] (450 mm total) only in the deeper part of the channel, with a transition to a single 150mm layer on the shallower left bank, the total volume of rock required would be approximately 1600m3.
- If the two more exposed and shallower pipes ([Sensitive Data] and [Sensitive Data]) require additional protection and three layers of [Sensitive Data] totalling 450 mm across the majority of the channel, then the required volume may increase up to a maximum of around 2000m3.
- Gravel to protect the exposed pipes is expected to total 360m3 in addition to the [Sensitive Data] volume but may vary with the lengths of pipe exposed when the works commence.

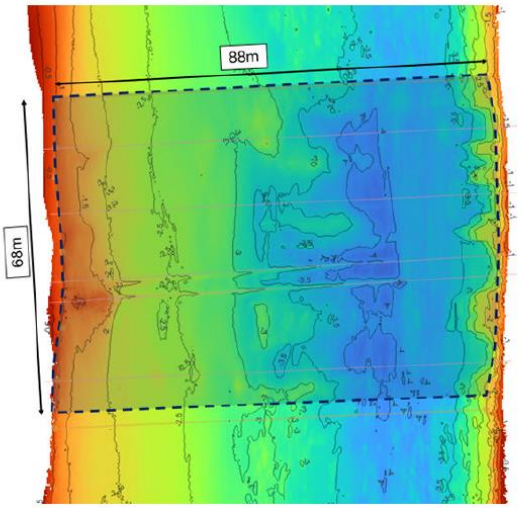

***Figure 102 - Plan area of the proposed** [Sensitive Data]*

For further detail on the preferred option please refer to **Appendix 18 –** [Security Data] **Technical Report.**

Project Delivery Plans and Risks

Risk	Mitigation
Inadvertent heavy contact with existing utilities/services resulting in injury and/or damage to infrastructure. (Construction)	To reduce the likelihood of damage, a 150mm thick gravel layer (of 25 to 50mm gravel) has been specified over the top of the pipe to prevent potential damage caused by the heavier 150mm diameter [Sensitive Data] scour protection. Rocks will also be guided into place via support divers throughout the works
Potential for disturbance/pollution affecting animals, plants, habitats, and the watercourse. (Environment)	A rock and gravel scour protection solution has been selected which does not contain cementitious materials during construction which could flow into watercourse.
Potential for scour protection over the exposed gas pipes to cause more erosion laterally or upstream and downstream. (Operations)	Additional one layer scour protection added at the western bank to manage the risk of lateral erosion. Protection extended to cover all 5 pipelines rather than just those which have already been exposed
Risk of drowning	Activities on site will be managed to reduce the likelihood of contact with water. The tidal window for diving conditions is short therefore putting divers at more risk. Only construction methods without the use of

	divers have been used for the preferred option and design
Risk of scour protection not being accurately placed or being moved during placement.	Gravel has been specified to be larger than the mobile bed material but may still move, so a survey of gravel coverage is required before rock is placed. [Sensitive Data] has been sized for the 0.5% Annual Exceedance Probability (AEP) (1 in 200 year) plus climate change fluvial flows with a further risk allowance.
Scour protection will raise bed levels leaving reduced draft for recreational and commercial vessels and increasing the risk of contact. (Public/Watercourse Users)	Significant reductions in available draft are limited to the worst-case scenario and to the shallow water close to the left (west) bank and the inside of the bend where no commercial vessels will operate. Existing signage warning of the gas pipes is in place and further signage is being discussed with [Third Party].
Work requires [Third Party] consent to commence, original meeting due 6th June 2023 timeline proposed in detailed design, risk to project delay if [Third Party] consent is refused	Series of meetings have been orchestrated between design and principal contractor to ensure smooth flow of the ABP consent and a clear line of sight when escalating complications

Figure 103 – [Security Data] Risks

Key Project Dates:

- Marine licence start & end dates in application are: 1st January 2024 to 31st December 2024
- Tender Return – 31/12/2023
- Tender Award – 15/01/2024
- Mobilise Construction – 15/02/2024
- Completion – 31/03/2024

Chapter 4.4.4 - Stakeholder Engagement

Stakeholder engagement will be required with the [Third Party] to get consent to proceed with the preferred option, no other stakeholders are impacted by the preferred option and therefore further stakeholder engagement was not appropriate in this context.

Chapter 4.4.5 – Cost Information

The costs are based on a quote from our mains work contractor and contain a breakdown of the estimated cost for delivery. Costs can be found in the "[Security Data] **Cost tab" in Appendix 1 - Diversions Re-Opener Finance Tracker.**

***Figure 104 – Total Adjustment for** [Security Data]*

Chapter 5.0
Loss of Development Claims

Chapter 5.1 – Problem Statement and Needs Case

Introduction to Loss of Development Claims

When Cadent wishes to lay a pipeline across a landowner's land, we will ask the landowner to agree to a voluntary agreement in the form of deed of easement. Cadent's template easement includes rights permitting it to construct the pipeline along a specific route in the land, to use the pipeline for the distribution of gas and to enter onto and have access over the land to maintain the pipeline. Easement rights are granted in perpetuity and survive a change of ownership. Therefore, the consideration paid for the rights is usually made only once.

Where the landowner is willing to negotiate and grant these rights to Cadent, we will pay a sum of money to the landowner in consideration for the grant of the easement and associated rights. The payment made will generally be based on existing use value and will not include a sum to compensate the landowner for any future loss of development. Historically, arrangements with landowners often included a provision entitling the landowner to make a claim if they can demonstrate (in accordance with the requirements set out in the deed) that the presence of the pipeline has prevented or curtailed development and consequently has caused loss to the landowner. This arrangement was typical in earlier iterations of Cadent, including when it was known as Transco and British Gas. However, as Cadent, we now avoid such arrangements, recognising that they expose us to significant risks. These risks mainly arise from potential claims for loss of development, which could be substantial in value.

Our process typically commences upon receipt of a notice of approach from a claimant. This Notice indicates their intent to undertake specific works, such as mineral extraction for a quarry or construction near our Pipeline for a property developer. Upon receiving this Notice, we will conduct an initial assessment to determine if the proposed works pose a risk of damage to our pipeline. After evaluating the potential risks, we issue a counter notice to the claimant. The claimant then begins preparing a detailed claim valuation, which might take several months to complete.

Once we receive this detailed claim, we embark on an in-depth review. This crucial step involves engaging specialist valuers to scrutinise the claim's validity and appraise its value. Their expert analysis is instrumental in preparing our comprehensive report for the landowner. If the landowner agrees with our assessment, we will settle the claim accordingly. Please note in a scenario where

a pipeline diversion is a more cost-effective option; this is also considered. On the other hand, if the claimants cannot provide sufficient evidence or justification, it becomes their responsibility to supply the necessary proof and detailed rationale, subject to our scrutiny and challenge.

The following sections below, provide a high-level understanding of loss of development claims and how they are assessed.

Legal Basis for Claims

A claim for loss of development can only be pursued by parties with a legal entitlement under the deed. This right extends to the original landowner or grantor and their successors. The definition of successors in title, which can significantly impact the scope of eligible claimants, is carefully interpreted based on the deed's language.

Criteria for Compensation

To succeed in a compensation claim, the claimant must navigate through three critical criteria, often referred to as the 'Three Limbs'. This is outlined in the table below:

	Description	Further Analysis
Limb One	This involves proving entitlement to compensation, which can be triggered by two scenarios related to planning permission and the grantor's covenants in the deed	Involves intricate considerations around planning permissions and the restrictions imposed by the pipeline
Limb Two	This limb focuses on mitigation, requiring that development of equivalent value can only be reasonably carried out elsewhere on the land without breaching the deed's covenants	Puts the onus on Cadent to demonstrate the feasibility of alternative development, considering various land conditions and existing developments
Limb Three	The final limb deals with the payment threshold. It stipulates that compensation is only due if it exceeds the sum initially paid when entering the deed.	Requires a careful analysis of compensation amounts, comparing compulsory acquisition compensation with the original deed sum.

Figure 105 – The three limbs

Final Considerations in Claim Assessment

When assessing a loss of development claim, we systematically evaluate the compliance with criteria under each of the three limbs. This process involves thoroughly evaluating the potential compensation and examining possible alternative resolutions to direct compensation payments. Such an assessment ensures a fair and equitable resolution, aligning with all parties' legal frameworks and interests. This comprehensive approach is crucial for maintaining the integrity and fairness of the claims process and ensuring that reasonable challenge has been made to the basis for, and quantum, of any loss of development claim.

Chapter 5.2 - Options Considered

Option 1 - Pipeline Diversion as an Alternative

An essential consideration in this process is whether the deed permits, or the circumstances allow the pipeline's diversion at the pipeline owner's cost as an alternative to paying compensation. This option may be more cost-effective in some scenarios and is be evaluated thoroughly. This option is usually considered when the claim amount is high e.g., over £1,000,000 for example in the case of [Security Data] outlined in Chapter 5.3. Figure 106 below shows a snapshot of our ongoing HP diversions projects and the costs associated with them. Please note that these projects are currently ongoing, and the final cost is yet to be determined but they provide an indication of the astronomical cost associated with a high-pressure diversion.

Figure 106 –high pressure diversion cost

Option 2 - Valuation and Negotiation of Compensation

Valuing the compensation involves complex assessments, considering factors like the valuation date, land conditions, and interest payable. In some cases, alternative solutions, such as technical adjustments or commercial settlements, might be negotiated.

Option 3 – Do Nothing

When a landowner possesses a legitimate claim for compensation under the terms of the deed and can substantiate it to our satisfaction through proper evidence, opting to 'do nothing' is not a viable choice. This is because we are legally obligated by the deed to assess and address such claims.

The following sections of this chapter will delve into more comprehensive details regarding the claims that have been utilised and those that are ongoing. Additionally, it will introduce a forecasting methodology to provide a clearer understanding of future trends and expectations for ongoing claims.

Chapter 5.3: [Security Data]

Chapter 5.3.1 – Problem Statement and Needs Case

Problem Statement and Needs Case

[Sensitive Data] shown in Figure 107 below.

Figure 107 – [Security Data]

[Sensitive Data].

[Sensitive Data]

Sensitive Data]

Sensitive Data].

Sensitive Data].

Sensitive Data].

Figure 108 – [Sensitive Data]

[Sensitive Data]

[Sensitive Data.]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

Chapter 5.3.2 – Options Considered

	#Option 1 – Pipeline Diversion	#Option 2 – Compensation	#Option 3 – Do nothing
Delivers business outcomes			
Effort to implement			
Cost to implement			

Legal compliance	[redacted]

Figure 109 – [Security Data] Options

The Red-Amber-Green (RAG) rating system served as a preliminary guide to evaluate each metric in terms of its positive (green) or negative (red) influence on the final solution recommendation. [Sensitive Data.]

Chapter 5.3.3 – Stakeholder Engagement

The Land Team thoroughly evaluated the notice of approach submitted by [Third Party], engaging pertinent stakeholders in a comprehensive decision-making process. Below is a detailed description of the roles played by each stakeholder involved in this strategic assessment.

Stakeholder	Role	Project Role
[redacted]	Claimant in the Compensation process	Initiate and negotiate the claim
Capital Delivery	Provided Diversions estimate	Offered counterfactual option to the claim to determine the most efficient option
[redacted]	Conducted technical and financial analysis of the claim	Analysed and validated the compensation of the claim for [Sensitive Data]

Figure 110 – Stakeholder engagement

[Sensitive Data]

[Sensitive Data]

The collective input from these stakeholders allowed for a well-rounded analysis, leading to a consensus that settling the claim was the most efficient and practical option.

Chapter 5.3.4 – Cost Information:

As this is a retrospective application and Cadent has settled the claim, the costs borne by Cadent as reflected in "**Loss of Development Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker** are actual costs incurred.

Figure 111 – [Security Data] adjustment (18/19)

Chapter 5.4 – [Security Data]

Chapter 5.4.1 - Problem Statement and Needs Case

[Sensitive Data]

Figure 112 [Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

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[Sensitive Data]

[Sensitive Data]

[Sensitive Data]
The evidence is supplied **in Appendix 35 –** [Security Data] **Section 81.**

Chapter 5.4.2 – Options Considered

	#Option 1 – Pipeline Diversion	#Option 2 – Compensation	#Option 3 – Do nothing
Delivers business outcomes			
Effort to implement			
Cost to implement			
Legal compliance			

Figure 113 – [Security Data] Options

Chapter 5.4.3 – Stakeholder Engagement

The Land Team thoroughly evaluated the notice of approach submitted by [Third Party]

Stakeholder	Role	Project Role
	Claimant in the Compensation process	Initiate and negotiate the claim
	Conducted technical and financial analysis of the claim	Analysed and validated the compensation of the claim for [Sensitive Data]

Figure 114 – [Security Data]

The collective input from these stakeholders allowed for a well-rounded analysis, leading to a consensus that settling the claim was the most efficient and practical option.

Chapter 5.4.4 Cost Information

As this is a retrospective application and Cadent has settled the claim, the costs borne by Cadent as reflected in "**Loss of Development Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker** are actual costs incurred.

Figure 115 – [Security Data] Claim Value

Chapter 5.5 – [Security Data]

Chapter 5.5.1 – Problem Statement and Needs Case

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]
[Sensitive Data]

All the information outlined below can be found in further detail attached in **Appendix 24 – [Security Data] Evidence.**

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

Appendix 24 – [Security Data] Evidence

Analysis

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]
[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]

[Sensitive Data]
[Sensitive Data]

[Sensitive Data]
[Sensitive Data]

[Sensitive Data]

Legal fees

[Cost-sensitive data]

Chapter 5.5.2 – Options considered

	#Option 1 – Pipeline Diversion	#Option 2 – Compensation	#Option 3 – Do nothing
Delivers business outcomes			
Effort to implement			
Cost to implement			
Legal compliance			

Figure 116 – [Security Data] Options

Chapter 5.5.4 – Cost Information

As this is a retrospective application and Cadent has settled the claim, the costs borne by Cadent as reflected in "**Loss of Development Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker** are actual costs incurred.

Figure 117 – [Security Data] Costs

Chapter 5.6 – [Security Data]

Chapter 5.6.1 – Problem Statement and Needs Case

[Sensitive Data]

Sensitive Data]

[Sensitive Data]
[Sensitive Data]

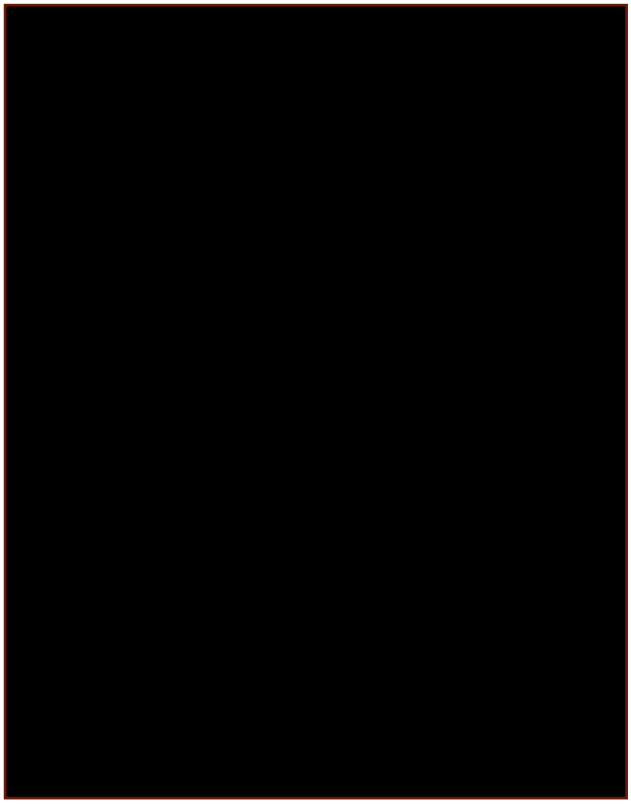

Figure 118 – [Security Data]

Comparable Evidence

[Sensitive Data]

[Sensitive Data]

Figure 119 – Comparable Evidence

Consideration of calculation

Figure 120 – Consideration of payable

Consideration payable

[Sensitive Data]

[Sensitive Data]

Chapter 5.6.2 – Options Considered

	#Option 1 – Pipeline Diversion	#Option 2 – Compensation	#Option 3 – Do nothing
Delivers business outcomes			
Effort to implement			
Cost to implement			
Legal compliance			

Figure 121** [Security Data] **Evidence

Chapter 5.6.4 – Cost information

As this is a retrospective application and Cadent has settled the claim, the costs borne by Cadent as reflected in "**Loss of Development Costs**" tab in **Appendix 1 – Diversions Re-Opener Finance Tracker** are actual costs incurred.

Figure 122 – [Security Data] Claim

Chapter 5.7 – Future loss of development claims

In this investment case, our sole focus is resolving loss of development claims, which are inherently reactive and triggered by claimant's actions. Due to this, forecasting the volume and complexity of future claims poses a significant challenge.

We have [Sensitive Data] claims in figure 123 below that we have a claim value for and are including these as part of our investment adjustment. We expect these claim amounts to be the maximum amount for these claims.

Claim Name	Current Progress	Claim amount

Figure 123 – Loss of development forecast – "LDC forecast tab" – Appendix 1 – Diversions Re-Opener Finance Tracker

Chapter 5.7.1 – Cost information - forecast

We have other ongoing claims below in figure 124. For some, we have already received a notice of approach. These claims are under review, including challenges issued to claimants to substantiate their claim, with pending responses. Given the dynamic nature of negotiations and legal proceedings, providing a detailed progress report on these claims is challenging at the time of drafting the Re-Opener. However, we have provided a high-level progress overview of each ongoing claim. The progress and outcomes of these cases can shift substantially during the Re-Opener submission process.

Moreover, our strategy is to allow claimants to fully present their case for compensation. This approach aligns with the principle that justifying the compensation claim rests primarily on the claimant. Consequently, we await substantiation for some of these claims, which will provide clearer grounds for negotiation and settlement.

Claim Name	Current Progress	Claim amount

***Figure 124** [Cost-sensitive data]*

There are a number of different options for using the claims above in figure 124 as the basis for the forecast:

- **Option 1**: The total value ongoing claims
- **Option 2**: A conservative view based on the likelihood of a claim being utilised
- **Option 3:** Additional Window - Uncertainty mechanism proposal at RIIO-GD2 Close out

Option 1 – Total value of ongoing claims (discounted)

Figure 125 below serves a dual purpose: it details claims with received amounts and estimates pending claims using an average unit cost of ongoing claim amounts received and historically utilised claims ([Security Data]). This method acts as a provisional measure for claims where we are currently awaiting amounts from claimants and offers a contingency plan. However, it's important to note that this method is not our preferred approach. The use of average unit costs, while practical, may not accurately represent the actual costs due to the significant variability in each claim. Historical patterns and site-specific characteristics offer limited insight into these costs, as the accuracy largely depends on the evidence provided by the claimants. Therefore, while Table 119 provides a necessary overview, its estimations should be considered cautiously, given these inherent limitations.

Claim Name	Current Progress	Claim amount	Expected Year of resolution

Figure 125 Notices of approach received

Option 2 – A conservative view based on the likelihood of a claim being utilised (discounted)

Regulatory Period	Number of claims utilised
[redacted]	[redacted]

Figure 126 No. of claims utilised

Figure 126 offers a comprehensive view of the volume of historical claims from the past [Sensitive Data] years. We are currently addressing [Sensitive Data] ongoing claims (outlined in figures 124 and 125), which we anticipate resolving during the remaining period of RIIO-GD2. However, based on a historical utilisation rate in figure 126 projecting a maximum of [Sensitive Data] claims for years 4 and 5 may yield a different estimate. The final amount could exceed our predictions, influenced by the validity and progress of each claim, thereby posing a risk of underestimating the total value and number of claims expected to be utilised. Additionally, while figure 125 (as referenced in Option 1) provides a high-level estimate of unit costs, it's important to recognise that the actual claims costs could be significantly higher. This suggests that Option 2 may not fully accommodate potential increases in claim costs, underscoring the need for a more flexible and comprehensive approach in our estimations and planning.

Option 3 – RIIO-GD2 Close out uncertainty mechanism (preferred)

Introduction

While we have knowledge of several pending claims expected to be resolved during RIIO-GD2, predicting their final costs is difficult due to significant uncertainties. Typically, the initial claim amounts indicate the potential maximum cost. However, each claim is unique, and its resolution often involves complex legal and investigative processes. Our challenges to these claims can lead to either a reduction in the settled amount or delays, as claimants may need extra time to gather supporting evidence. It's important to note that even if the outcome appears favourable for Cadent, such as a reduced claim value, there are scenarios where we must settle if the claimant provides sufficient evidence. This is especially true in cases where an alternative, more cost-effective solution such as a diversion is not viable.

Loss of development claims will continue to be driven by a third party. Through existing engagement, we have visibility over several claims that are likely to be resolved in RIIO-GD2, shown in figure 125 above. However, there is considerable uncertainty on the specific timing of these works i.e., when we expect to receive or settle a claim, and the final cost.

Why we have forecasting difficulty?

While we can consider the profile of costs incurred to date in RIIO-GD2 and our engagement with developers and other third parties have indicated potential future claim settlements that may be required, it is extremely challenging to establish a total cost estimate for inclusion in our plan. This uncertainty is driven both by the volumes of work we will be required to undertake and by the costs of doing so:

Volumes - Claim volumes during RIIO-GD2 are unpredictable and largely dependent on third-party demands, which can arise unexpectedly. These claims are beyond Cadent's control. For instance, a property developer might encounter issues building on a plot with our pipeline, or a quarry operator could face challenges in mineral extraction due to the presence of our apparatus.

We've outlined expected claims for resolution in RIIO-GD2 in figure 123. However, there remains the possibility of unforeseen claims emerging in Years 4 or 5. Historically, it takes us about [Sensitive Data] to investigate and settle a claim. A notable exception was the [Security Data] claim (referenced in chapter 5.4), which we resolved [Sensitive Data] of receiving the claim amount. While we don't anticipate [Sensitive Data], the potential for unforeseen claims remains, especially if the claimant presents sufficient evidence, as seen in the [Security Data] case.

Costs - Each claim in RIIO-GD2 is unique and influenced by the specific characteristics of the individual site. This variability makes predicting the total impact on the programme's cost challenging. Additionally, negotiations with landowners and any associated legal costs further complicate these estimations.

Options for addressing uncertainty

Mechanism Option	Description
Volume driver (discounted)	A volume driver is not wholly appropriate for this risk. Whilst we have visibility of costs for some ongoing claims (where we have received a claim amount). It would be inappropriate to develop unit costs across the full range of potential settlements, which would require an assumption based on a historical average cost and is not representative as each case varies significantly.
Additional Window - Re-opener (preferred)	An additional Diversions Re-opener window under the existing Special Condition 3.20 Diversions and Loss of Development Claims re-opener policy and subject to the existing materiality threshold. Similar to our proposal in chapter 3.1.7 option 1. This accounts for uncertainty in costs when the requirements for projects in RIIO-GD2 are unknown. In this scenario, it relates to the uncertainties we face in providing a cost estimate associated with loss of development claims. Elements of this, are well suited to this

	mechanism, as the specification of works we will be required to undertake is currently unknown. This mechanism, if it were to be permitted at close out of RIIO-GD2 would allow us to develop an evidence-based cost approach at the end of the RIIO-GD2 period once the scope of legal review is clearly outlined with accompanying cost evidence, which would be subject to review from Ofgem.
Use it or lose it allowance or PCD – (discounted)	This would involve a use it or lose it allowance (UIOLI) or price control deliverable (PCD). While this would protect consumers from under-delivery, a UIOLI or PCD does not address the challenge we face in forecasting a total cost when the volume and unit costs of claims are unknown. There is also a risk that barriers are created if there are insufficient funds to deliver against any new claims as mentioned above.

Evaluating our proposed Additional uncertainty mechanism window

An additional re-opener window allows us to respond to the demands of consumers and developers at close out of the RIIO-GD2 period. This provides an opportunity to provide higher-confidence cost evidence. As outlined above, there are risks associated with including a cost estimate in our Re-Opener at present, creating opportunities for Cadent to make losses or windfall gains, specifically around more complex activities.

Nevertheless, it is important to fully evaluate the behaviours that our proposed uncertainty mechanism will encourage, to ensure it does not create perverse incentives. Below, we consider positive behaviours that a mechanism should promote.

Behaviours and incentives	Evaluation
To minimise costs	The costs we submit to Ofgem through the re-opener process will be subject to review and challenge. Any costs identified as inefficient will be disallowed. This creates an incentive to focus on incurring or estimating efficient costs and demonstrating this with robust evidence.
To deliver required work	Ofgem will also focus on ensuring that these only relate to relevant activities. Any costs submitted for work Ofgem do not believe to be required will be disallowed, creating an incentive to focus on work with a compelling need. This will ensure that work which can be objectively defined as ‘loss of development’

	will be included, in line with existing reporting guidelines under the RPP.
Consumer Protection	As costs will be subject to scrutiny from Ofgem, it ensures we only provide costs incurred for settling a claim as opposed to providing over inflated estimates of difficult to predict claims protecting consumers from fluctuations in their bills.

Our proposals for a re-opener mechanism are clear and simple for our consumers to understand. We only propose to request funding for the costs we efficiently incur in response to settling loss of development claims.

Chapter 6.0
Appendices

Chapter 6.1 Supporting Documents

Appendix #	Appendix File Name
Appendix 1	Diversions Re-Opener Finance Tracker .xlsx
Appendix 2	Awaiting Land Remediation.xlsx
Appendix 3	Cadent's Options Analysis Methodology .pdf
Appendix 4	[Security Data] Repair Evidence.pdf
Appendix 5	[Security Data] Detailed Design Document – [DNV].pdf
Appendix 6	[Security Data] assessment.pdf
Appendix 7	[Security Data] feasibility .pdf
Appendix 8	[Security Data] 2008 Report .pdf
Appendix 9	[Security Data] 2011 [Sensitive Data] report .pdf
Appendix 10	[Security Data]2016 Report .pdf
Appendix 11	[Security Data]2017 Report .pdf
Appendix 12	[Security Data]Geotechnical Report .pdf
Appendix 13	[Security Data]Soil - Pipeline Interaction Analysis.pdf
Appendix 14	[Security Data] Optioneering Report.pdf
Appendix 15	[Security Data] Report .pdf
Appendix 16	[Security Data] Report.pdf
Appendix 17	[Security Data] Optioneering Report .pdf

Appendix 18	[Security Data] Technical Report .pdf
Appendix 19	[Security Data] Counter Notice .pdf
Appendix 20	[Security Data] Evidence.pdf
Appendix 21	[Security Data] Diversion Cost .pdf
Appendix 22	[Security Data] - Notice of Approach.pdf
Appendix 23	[Security Data] Section 78.pdf
Appendix 24	[Security Data] Evidence.pdf
Appendix 25	[Security Data] Counter Notice .pdf
Appendix 26	[Security Data] Claim.pdf
Appendix 27	[Security Data] Claim Document.pdf
Appendix 28	[Security Data] Claim.xlsx
Appendix 29	[Security Data] Notice of Approach.pdf
Appendix 30	[Security Data] Notice of Approach.pdf
Appendix 31	[Security Data] Lane Deed.pdf
Appendix 32	[Security Data] Lane Loss of Revenue.pdf
Appendix 33	[Security Data] Notice of Approach.pdf
Appendix 34	[Security Data] Notice of Approach.pdf
Appendix 35	[Security Data] Section 81 evidence.pdf

Chapter 6.2 – Glossary of Terms

Acronym	Description
CNI	Critical National Infrastructure
FTE	Full Time Employee
HSE	Health & Safety Executive
PRS	Pressure Regulating Station
LP	Low Pressure
MP	Medium Pressure
IP	Intermediate Pressure
HP	High Pressure
LDP	Local Delivery Partners
TM	Traffic Management
DMP	Design Minimum Pressure
PSR	Pipeline Safety Regulations
MRPS	Mains replacement prioritisation system