Cadent
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Appendix 09.16
Winnington Lane Crossing Replacement
RIIO-2 Spend: XXXX

Investment Decision Pack Overview

This Major Project Engineering Justification Framework outlines the scope, costs, and benefits of our proposals for the Winnington Lane Crossing. This project will cost in excess of XXXX; therefore, it will be highlighted as a separate scheme[1] in BPDT 2.04 and we have prepared a Major Project Justification Paper (this appendix) and Cost Benefit Analysis (CBA) for it.

Overview

The Winnington Lane medium pressure (MP) crossing is a 180mm PE main inserted in an exposed 8" asbestos-cement (AC) pipeline attached to the side of the A533 road bridge across the River Weaver, in NW Network.

The pipe brackets supporting the live AC/PE pipeline are in poor condition and some have already failed. A complete failure of the AC pipeline would damage the bridge structure and the PE main within, releasing asbestos fibres into the surrounding environment. If structural failure were to cause loss of containment from the live pipe then there would also be potential for ignition, given the presence of passing traffic. As a one-way feed, an outage at the crossing would cause loss of supply to ~2,000 customers. Given the access issues, any such outage would be protracted, even for an emergency repair (if possible).

The following **options** have been considered to address the issues with the existing crossing:

- Baseline: Reactively repair and replace the crossing on failure. This option assumes that an emergency repair would be made to restore supply as soon as possible after failure and that, having failed once, the crossing would then be replaced.
- Option 1: Proactively divert the pipe by building a new pipe bridge over the river, structurally separate from the road bridge.
- Option 2: Proactively divert the pipe by directionally drilling a new crossing under the river.
- Option 3: Proactively repair the existing pipeline's supports. This would leave the AC/PE main *in situ*.

We rejected the baseline and Option 3 before monetisation because they are either contrary to safety legislation (Baseline) or have significant technical difficulties (Option 3).

We undertook a CBA on Options 1 & 2 — both involve proactively diverting the pipeline — taking account of impacts such as traffic disruption and the avoided costs of reacting to a failure. These two options have the same benefits profile and have the same total cost estimate. The CBA shows that these options are cost beneficial.

We have therefore selected proactive diversion — *either* Option 1 or Option 2 — as the preferred option. We propose to develop detailed designs for both options and make a final decision once these detailed designs have been costed.

Summary of preferred option	
RIIO-2 Expenditure (2018/19 price base)	Redacted due to commercial sensitivity
Project NPV	

[1] Investment case 09.36 covers more-routine crossings investment.

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Material Changes Since October Submission

The paper is now written in an 18/19 prices and a small increase has been made to project management cost.

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2. Summary Table

Name of Project	Winnington Lane Crossing Replacement		
Scheme Reference	Cadent Line #158 Winnington Lane Diversion		
Primary Investment Driver	Security of supply		
Project Initiation Year	2019		
Project Close Out Year	2022		
Total Installed Cost Estimate (£m)	XXXX		
Cost Estimate Accuracy (%)	±15%		
Project Spend to date (£)	XXXX		
Current Project Stage Gate	Design study in progress		
Reporting Table Ref	2.04 Mains Diversions/Non-Chargeable Mains Diversions/Tier 1/ split over diameters		
Outputs included in RIIO-1 Business Plan	No		
Spend apportionment	**RIIO-1**	**RIIO-2**	**RIIO-3**
	XXXX	XXXX	

Table 1: Summary table for Winnington Lane Crossing MP diversion (RIIO-2 costs have 2018/19 price base)

3. Project Status and Request Summary

This is a new project.

There is an existing medium pressure (MP) crossing of the River Weaver at Winnington Lane Bridge near Northwich, Cheshire, which is in poor condition and has a high probability of failure. This project will look to reduce or mitigate this risk in the most cost-effective manner.

A study is currently underway assessing the various ways that this existing pipework can be repaired, replaced, decommissioned, or diverted, to provide a safe and reliable gas supply.

This work has not been included in Appendix 09.36 Pipeline Crossings because it will cost more than XXXX. Accordingly, it will be highlighted as a separate scheme in BPDT 2.04 and we have prepared an Engineering Justification Paper (this appendix) and Cost Benefit Analysis (CBA) for it.

The Winnington Lane Crossing has a Health Index of HI5. Therefore, this planned intervention in RIIO-2 is consistent with the prioritisation scheme that we use for other, non-major project crossings (see Appendix 1).

4. Problem Statement

The Winnington Lane MP crossing is a 180 mm Polyethylene (PE) main inserted in an exposed 8" asbestos-cement (AC) pipeline attached to the side of the A533 road bridge across the River Weaver[2] northwest of Northwich, Cheshire (Figure 1). It is the one-way feed to six low-pressure district governors supplying approximately 2,000 customers in Comberbach and Barnton (Figure 2).

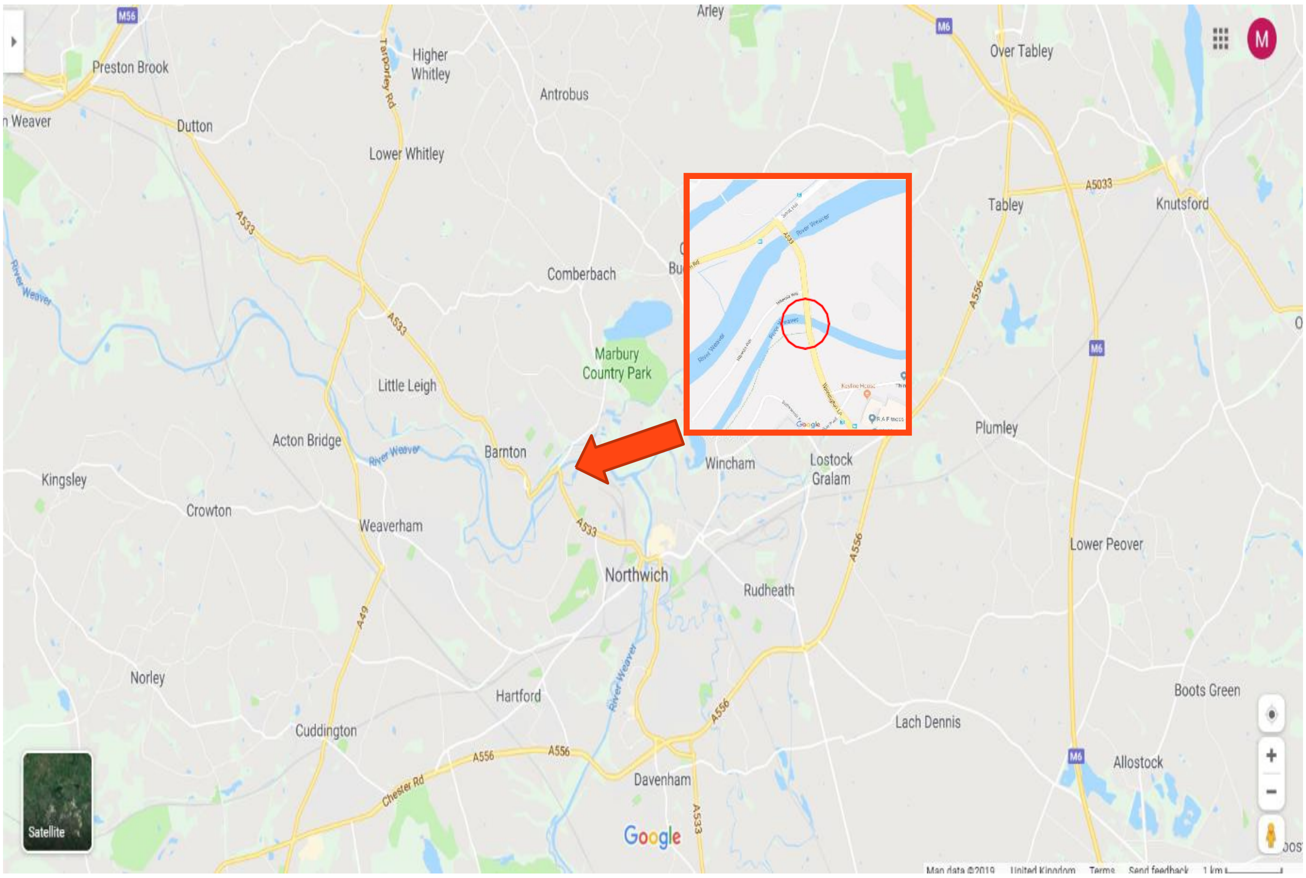

Figure 1: Location of Winnington Lane crossing

[2] That is, the natural flow of the river at this point and not the River Weaver Navigation to the north.

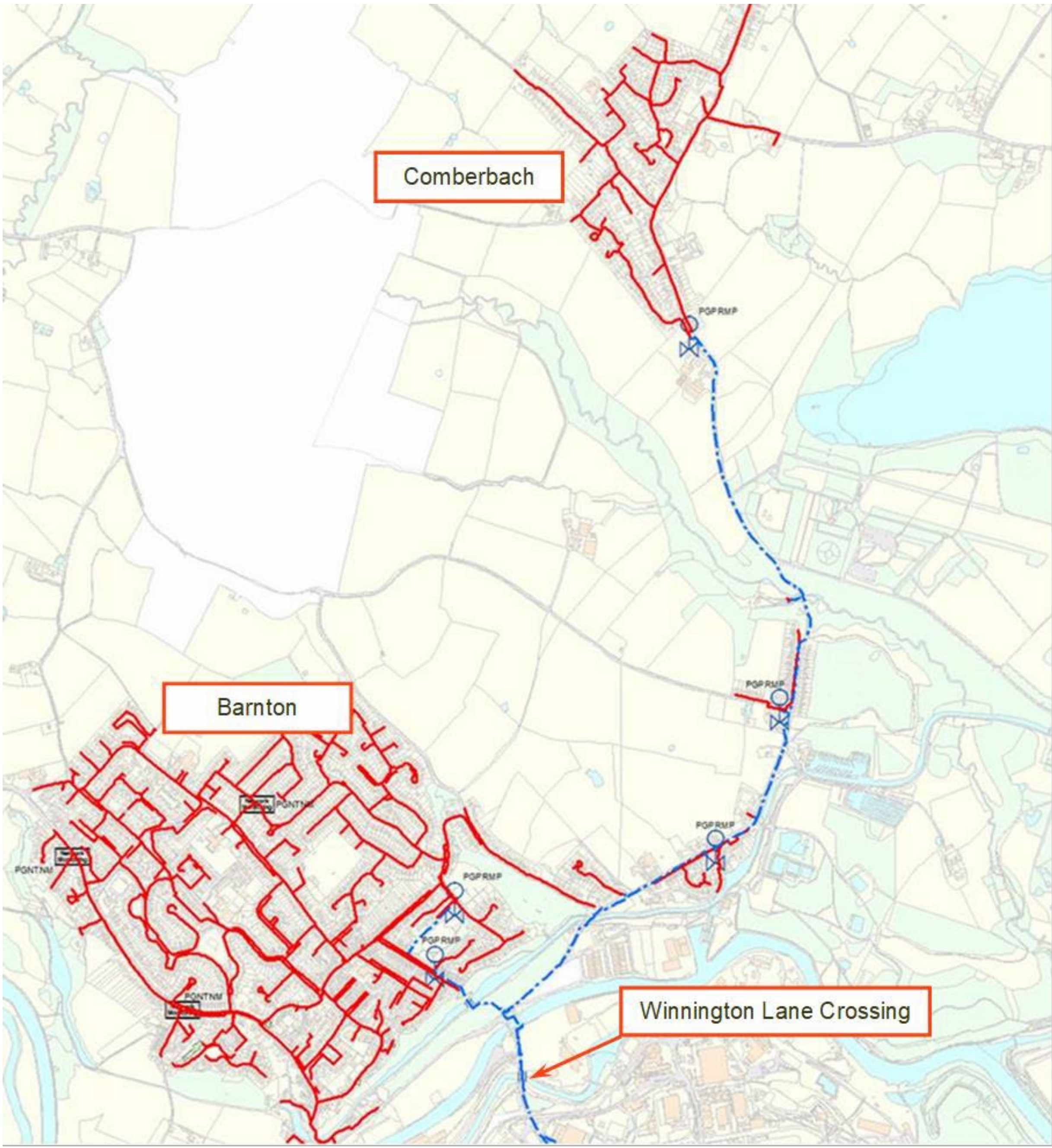

Figure 2: LP networks supplied via Winnington Lane crossing

Winnington Lane crossing is approximately 25m long and attached to the east side of the A533 road bridge by pipe brackets tied into the sandstone structure. This bridge also carries a decommissioned 12" steel (former MP) pipeline below the live pipeline. The steel main is supported by bracket connection on to metal I-beams cantilevered in the bridge structure by concrete blocks, with a minimum volume of 16 cubic feet (Figure 3).

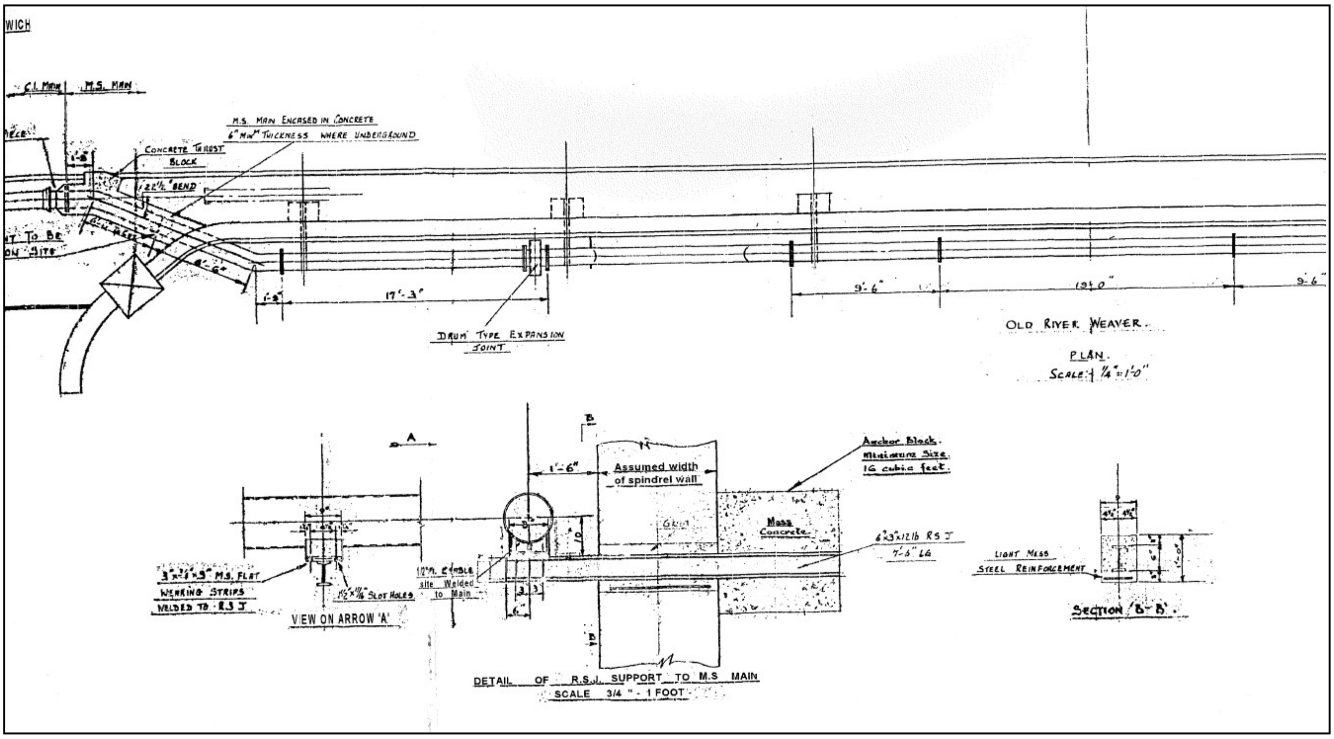

Figure 3: Details of 12" steel pipeline and its supports

The pipe brackets supporting the live AC/PE pipeline are in poor condition (Figure 4). Some have failed (see Figure 5, for example) so that, in places, the AC pipeline is distorted and resting on the decommissioned steel main (Figure 6) so that it is supported in turn by the recessed I-beam support system. In addition to causing extra stresses in both pipelines, this will have upset the steel main's mass balance, putting unplanned stresses on the bridge structure.

Thus, the structure of the pipe crossing is compromised: some structural failures have already occurred, and the asset continues to deteriorate. A complete failure of the AC and steel pipelines would damage the bridge structure and the PE main within the sleeve, and potentially release asbestos fibres into the surrounding environment.

If structural failure were to cause loss of containment from the AC/PE pipe then there would be potential for ignition, given the presence of passing traffic.

As a one-way feed, an outage at the Winnington Lane crossing would remove supply to six low pressure district governors and hence cause loss of supply to approximately 2,000 customers. Given the access issues that require scaffolding to be cantilevered off the bridge deck, any such outage would be protracted, even for an emergency repair (if possible).

It should also be noted that the crossing does not have adequate Access Deterrent Measures (ADM) in place, with an ADM risk score of 24.

Integrity assessment

Cadent has recently engaged DNV GL to undertake an integrity assessment and stress analysis on the current situation at Winnington Lane to determine the integrity, suitability, and capacity of the I-beams that are supporting the abandoned 12" steel main to take additional loading from the 8" AC/PE MP main, and to identify and quantify detrimental effects on pipe integrity.

The findings from this study will drive any reactive investment in RIIO-1 required to secure the integrity of the asset until resource is available to undertake the long-term solution of pipe replacement.

Figure 4: Example of deteriorating clamp bracket, the AC/PE main is at the top of the photograph

Figure 5: Failed clamp bracket, AC/PE main in the foreground, wrapped steel pipe at the back

Figure 6: Unsupported AC/PE main resting on decommissioned steel pipeline

Investment drivers

The primary driver for the proposed investment is to maintain a safe and secure supply to properties that depend on this MP main as their sole source of gas. Without intervention, the live main's pipe-supports will deteriorate to failure over time. This will create further abnormal loads on both pipelines and the bridge, which can in turn progress to cause or contribute to leakage from the live main.

In summary the main investment drivers are:

- **Risk of a gas emergency incident,** which would lead to A-road closure.
- **Safety of the public**: a gas leak would put the general public at risk from fire or explosion.
- **Security of supply**: as a single point of supply, a failure at this crossing would cause loss of supply to 2,000 customers while the leak was repaired.
- **Compliance with legislation:**
    - We must comply with the Pipeline Safety Regulations 1996, particularly Regulation 13 (the obligation to '… [maintain a pipeline] in … good repair')
    - We must comply with the Health and Safety at Work Act.
- **Threat to civils integrity (damage to A-road bridge)**: unbalanced loads on the 12" pipe's support system put non-vertical stresses on the bridge parapet, for which it is not designed.
- **Threat to asbestos cement pipe:** although it no longer carries gas directly, failure of this pipe would release asbestos fibres[3].

[3] Noted as part of Cadent's risk register entry for the Winnington Lane Crossing.

Project challenges and complexities

The preferred approach to this problem (Section 8.1) is to divert the crossing using a pipe bridge or directional drilling, with the final decision depending on surveys of ground conditions, topography, and site access. Both existing crossing pipelines would be removed.

Either approach will present similar complexities of access to the narrow and congested road bridge for pipe removal, which will need close liaison with the Highways Authority and might delay the removal phase of work into a ‘window’ of minimal traffic density. However, none of the challenges is regarded as exceptional.

Key milestone dates

Completion is currently expected to be in 2022/23.

Interim milestones have not yet been identified for this project.

Understanding project success

Success of this project will ensure we have a safe and reliable gas network that provides an uninterrupted gas supply to customers in the surrounding area.

The new infrastructure will be designed in line with our Licence obligations to maintain pressures at extremities under current and forecast extreme-day (1 in 20) conditions.

Successful completion of this project will see Cadent’s redundant pipelines removed from Winnington Lane road bridge.

We would also ensure that the AC pipeline is safely removed for appropriate waste treatment.

4.1. Related Projects

There are no related projects.

4.2. Project Boundaries

The scope costed in this paper covers front-end engineering design and construction of the preferred solution and removal of redundant assets.

Risks associated with the above-ground gas pipeline on Winnington Lane will be mitigated by this project.

5. Project Definition

5.1. Supply and Demand Scenario Discussion and Selection

No major demand changes are expected in areas supplied via the Winnington Lane crossing. Current local plans for new housing are concentrated around Northwich, south of the crossing, and there are no known plans for new industrial loads north of the crossing.

We have developed the options described in Section 6 to deal with the issues set out in Section 4. All these options retain the capacity of the existing crossing. Network modelling has shown that this capacity could support up to approximately 1,000 new homes. Therefore, the base case scenario was taken as current demand in the knowledge that any reasonably-foreseeable change to this could be accommodated.

5.2. Project Scope Summary

The project will mitigate the structural and pipeline integrity risks associated with approximately 25m of AC/PE pipework on the Winnington Lane road bridge.

6. Options Considered

The following options have been considered for the Winnington Lane crossing:

- **Baseline**: Reactively repair and replace the crossing on failure. This option assumes that an emergency repair would be made to restore supply as soon as possible after failure and that, having failed once, the crossing would then be replaced.
- **Option 1**: Proactively divert the pipe by building a new pipe bridge over the river, structurally separate from the road bridge.
- **Option 2**: Proactively divert the pipe by installing a new crossing under the river by directional drilling.
- **Option 3**: Proactively repair the existing live pipeline's supports to realign it out of contact with the decommissioned main. This would leave the AC/PE main *in situ*.

6.1 Baseline: reactive repair

The option of reactive repair for Winnington Lane crossing was rejected because of the nature of the time-dependent threats identified in Section 4. The condition of brackets that are still intact is mostly poor and, without intervention, will continue to deteriorate to failure. Thus, a reactive approach to repairs will impose further unplanned stresses on the live main, decommissioned main and bridge structure with potential for local failure of the bridge parapet or deck and/or failure of the live main causing loss of gas.

This is not considered to be responsible management of the asset in line with Cadent's obligation to maintain a safe and secure network, in particular under PSR 1996 (Regulation 13). Therefore, this baseline option has been dismissed from consideration.

6.2 Option 1: proactive diversion — standalone pipe bridge

This option would replace the existing PE/AC insertion with new pipe carried above the river by a pipe bridge (fitted with suitable Access Deterrent Measures). The location of the pipe bridge would be determined during detailed design, subject to a survey of ground conditions and topography.

Both pipelines currently fixed to the A533 bridge would be removed and the bridge structure made good according to the terms of Cadent's agreement with the Highways Authority.

6.3 Option 2: proactive diversion — directional drilling

Under this option, new pipe would be inserted under the river bed by directional drilling. As with the pipe bridge option the location of the new crossing would be determined during detailed design, subject to a survey of access to and topography of both banks of the river. Below-ground conditions would also have to be surveyed to confirm suitability for drilling and pull-through.

Both pipelines currently fixed to the A533 bridge would be removed and the bridge structure made good.

6.4 Option 3: proactive repair in situ

Remediation of the existing crossing would replace all the live pipeline's supports and realign it so that it is level and no longer in contact with the decommissioned steel main.

This would address the concerns noted above about potential failure of the bridge and/or live main.

This scheme has been rejected due to the following technical difficulties:

- As the bridge is sandstone, the existing type of support would no longer be accepted by the local highway authority. A method such as the cantilevered I-beams used for the more recently installed but now-decommissioned 12” steel pipe would be necessary, adding substantially to the engineering difficulties and duration of works.
- Long-term traffic management would be necessary, causing major disruption to users of the A533 (which is also constricted by the single-lane swing bridge north of Winnington Lane Bridge) and the surrounding road network.
- The asbestos carrier pipe would remain in place, contrary to current practice.

These issues would increase the duration of construction and associated disruption, and add significantly to delivery costs.

6.5. Options Cost Estimate Details

High-level budgetary cost estimates for the two proactive diversion options have been derived from tendered costs for similar projects completed in recent years (Table 2 and Table 3).

These cost estimates have both assumed that the diversion would be a 180 mm steel pipeline. However, details of the new pipe will be fixed later in the design process.

These budgetary costs are subject to revision as design progresses. We have, therefore, included appropriate contingencies for both options. (Note that the contingency for directional drilling is larger in absolute and percentage terms because, in addition to uncertainties concerning bankside topography and geophysics that are common to both options, the cost of directional drilling will be affected by riverbed geophysics).

Option 1: proactive diversion by standalone pipe bridge

Item	Cost (£m)	% of Total Installed Cost
Total Installed Cost		
Engineering Design		
Project Management		
Materials		
Main Works Contractor	Redacted due to commercial sensitivity	
Specialist Services		
Vendor Package Costs		
Cadent Direct Costs		
Cadent Indirect Costs		
Contingency		
Cost Estimate Accuracy	±15%	

Table 2: Budgetary costs (2018/19 price base) for Option 1 — proactive diversion by standalone pipe bridge

Option 2: proactive diversion by directional drilling

Item	Cost (£m)	% of Total Installed Cost
Total Installed Cost		
Engineering Design		
Project Management		
Materials		
Main Works Contractor		
Specialist Services	Redacted due to commercial sensitivity	
Vendor Package Costs		
Cadent Direct Costs		
Cadent Indirect Costs		
Contingency		
Cost Estimate Accuracy	±15%	

Table 3: Budgetary costs (2018/19 price base) for Option 2 — proactive diversion by directional drilling

6.6. Options Summary

Option Title	Baseline	Proactive Diversion		Proactive Repair
	Reactive Repair	Option 1: Standalone Pipe Bridge	Option 2: Directional Drilling	Option 3, proactive repair in-situ
Start Date	We are aware of deficiencies; not remediating them within a reasonable timescale and allowing failure would breach our legal obligations under PSR 1996.	2021	2021	This option has been discounted because of significant technical difficulties associated with pipe supports, traffic management, and the risks from leaving the asbestos pipework in place, which in turn could increase delivery costs substantially.
Commissioning Date		2022	2022	
Design Life (yrs)		40	40	
Operating Costs (£m)		[redacted] Redacted due to commercial sensitivity	[redacted]	
Total Installed Cost (£m)		[redacted]	[redacted]	
Cost Estimate Accuracy		±15%	±15%	

Table 4: Summary comparison of costed options (2018/19 price base)

We have a preliminary design for this expenditure with costings derived from tendered costs for similar projects completed in recent years. This has been further checked against recent delivery of projects as a part of diversion activities.

7. Business Case Outline and Discussion

This section outlines the results of our options analysis. Appendix 2 sets out the CBA approach and results.

7.1. Key Business Case Drivers Description

The choice of the preferred option in the CBA is driven by the benefits of:

- Avoiding the risk of reactively responding to a failure.
- Avoiding the risk of failure leading to interruptions to supply and traffic disruption.

The benefits of avoiding the cost of reactively responding to a failure combined with the costs of traffic disruption are enough to make the preferred option cost beneficial even without the inclusion of the benefits of avoiding interruptions to supply.

7.2. Supply and Demand Scenario Sensitivities

As noted in Section 5.1, the base case of current demand ±10% is considered to cover all reasonable scenarios of future demand north of the Winnington Lane crossing, so other scenarios have not been proposed.

The Winnington Lane pipeline would be required irrespective of the supply-demand scenario. The current peak demand scenario would need to reduce by circa 15 – 20% to allow the pipeline size to be reduced to the next standard size at Winnington, which would in any case have a marginal impact on the overall cost that is dominated by other elements. We have therefore concluded that this investment case is not materially impacted by variations in the supply-demand scenario selected.

7.3. Business Case Summary

We have a clear duty to ensure the safe operation of our pipeline. Exposed asbestos pipes and failed pipe supports are not acceptable.

As discussed earlier we have a legal obligation to remediate known deficiencies as soon as reasonably practical, to ensure we comply with our PSR 1996 (Reg 13). We have however used CBA for illustrative purposes to show that, even without this legal mandate, a proactive approach to remediation is optimum.

We have considered the following options to remediate the Winnington lane pipe crossing.

Option Title	Baseline	Proactive Diversion		Proactive Repair
	Reactive Repair	Option 1: Standalone Pipe Bridge	Option 2: Directional Drilling	Option 3, proactive repair in-situ
Start Date	We are aware of deficiencies; not remediating them within a reasonable timescale and allowing failure would breach our legal obligations under PSR 1996.	2021	2021	This option has been discounted because of significant technical difficulties associated with pipe supports, traffic management, and the risks from leaving the asbestos pipework in place, which in turn could increase delivery costs substantially.
Commissioning Date		2022	2022	
Design Life (yrs)		40	40	
Operating Costs (£m)		-	-	
Total Installed Cost (£m)		XXXX	XXXX	
Cost Estimate Accuracy		±15%	±15%	
NPV (including WTP to supply interruptions)	N/A	Redacted due to commercial sensitivity		N/A
Payback year		2024		
NPV ratio to RIIO-2 spend		XXXX		

Table 5: Business Case Summary (2018/19 price base)

We have carried out sensitivity analysis to test how the CBA is changed by removing willingness to pay to avoid supply interruptions and only including the social benefits from avoiding traffic disruption. Although the NPV reduces to 0.73, it takes longer to payback (payback year is 2038), and the 'NPV ratio to RIIO-2 spend' becomes 0.95, the scheme is still cost beneficial.

We are therefore confident that a proactive diversion (either Option 1 or 2) is the optimum approach for RIIO-2 and ensures that we comply with our legal obligations under PSR 1996 (Reg 13).

Option 1 or 2 will also allow decommissioning and removal of the current PE/AC pipeline on Winnington Lane Bridge while ensuring security of supply under current and expected future demands.

Further detail on the CBA undertaken is included in Appendix 2.

8. Preferred Option Scope and Project Plan

8.1. Preferred Option for this Request

The preferred option is to install a new crossing. The lower-cost option of Option 1 (standalone pipe bridge) or Option 2 (directional drilling) will be selected when detailed designs have been costed.

8.2. Project Spend Profile

RIIO-2 Year	2021/22	2022/23	2023/24	2024/25	2025/26
Spend (£m)	Redacted due to commercial sensitivity				

Table 6: Total annual spend (£m, 2018/19 price base) to project completion for preferred option of proactive diversion

8.3. Efficient Cost

Our cost estimates for work at Winnington Lane are based on unit costs for similar work delivered, following a tendering process, during RIIO-1. We are therefore confident that they are efficient.

Our RIIO-2 forecasts, as well as adjusting for workload and work mix factors, also include ongoing efficiencies flowing from our transformation activities including from updating and renewing our contracting strategies. Our initiatives are outlined in Appendix 09.20 Resolving our benchmark performance gap. For Capex activities this seeks a 2.9% efficiency improvement by 2025/26 on the end of RIIO-1 cost efficiency level. We have not applied a specific efficiency to this investment.

Winnington Lane Crossing Replacement has various estimates of confidence stages. We have delivered very similar projects during RIIO-2 and as such have a good confidence in certain elements of the cost, there is still however some uncertainty given that geo-physical surveys have not yet been completed. Our confidence is at Detailed Design stage with a range of ±15%.

8.4. Project Plan

This project is at an early stage of development and there is not yet a firm plan for the works. Cadent expects to be ready to place orders for the work in 2021 for completion by 2023.

8.5. Key Business Risks and Opportunities

This proposal is for essential work to ensure security of supply by addressing structural issues at the existing Winnington Lane crossing. However, certain events could invalidate or substantially modify the argument for, or scale of, work proposed here:

- If there was to be significant demand growth in the area supplied by the River Weaver crossing north of Winnington Lane Bridge, then the crossing's planned capacity would be inadequate.

- As noted in Section 5.1, there are currently no industrial or power-generation gas consumers planned for construction in the area supplied by this crossing. Additionally, modelling has shown that up to 1000 extra homes could be supplied using the planned capacity. Therefore, the likelihood of this event is considered very low.

- The decision between directional drilling and building a pipe bridge cannot be made until site surveys have been completed and detailed costings prepared. The cost estimates presented in Sections 6.2 and 6.3 have appropriate contingencies to cover this uncertainty and, as such, the risk is with Cadent.

Reference	Risk Description	Impact	Likelihood	Mitigation /Control
09.16 - 001	Supply & Demand deliverability risk of resource availability within the Gas industry	Potential cost increases in labour / commodity markets as demand is greater than supply	Low	Intelligent procurement and market testing. Apprenticeship and Training programmes to fill skills gaps
09.16 - 003	Unforeseen outages and failures restrict access for planned work	Programme and delivery slippage due to delay of planned outages and or site access	Low	Proactive asset management with ongoing condition surveys and response plans to prevent failures
09.16 - 004	Unseasonal weather in 'shoulder months', Autumn and Spring reduce site access/outage windows	Increased demands affecting access to sites and planned outages delay and cost increases	Low	Controlled forecasting and maintenance of flexibility to react to unforeseen events. Detailed design solutions to minimise outages and reduce exposure.
09.16 - 005	Unexpected / uncommunicated obsolescence during RIIO-2 period of equipment components	Inability to maintain equipment at full capacity with risk of impact upon supply	Low	Maintain a close relationship with equipment supply chain and manage a proactive early warning system where spares / replacements become at risk.
09.16 - 006	Legislative change - There is a risk that legislative change will impact the delivery of our work.	Potential increase in the amount of consultation and information exchange required and require us to align our plans with the safety management processes operated by 3rd Party landowner / asset owners. The potential impact is	Med	We have established management teams to address these issues. We have also identified UMs for key areas.

		more engagement and slower delivery		
09.16 - 007	Geophysical surveys have not yet been completed, and may impact options available	Cost and time impact	Med	We have costed two different intervention options, which have similar outturn costs. Potential for two viable options.
09.16 - 008	Significant demand growth in the area	Inability for supply to be maintained over Winnington Lane crossing	Low	Constant monitoring of Supply and Demand in the network to meet future known demands.

Table 7: Risk Register

8.6. Outputs Included in RIIO-1 Plans

This work was not included in RIIO-1.

9. Regulatory Treatment

This investment will not be processed through the NARMs reporting tool.

The workload will be reported through RRP and cost variance managed through the Totex Incentive Mechanism (TIM).

This investment is accounted for in the Business Plan Data Table 2.04 (Non-Routine Maintenance within the Other Non-Routine Maintenance Sub-Table under Winnington Lane.

Appendix 1: Intervention Priority

This intervention flow chart for below-7bar crossings (taken from Appendix 09.36 Pipeline Crossings has been annotated to show the prioritisation applicable to Winnington Lane, which has an ADM risk score of 24 and Health Index 5.

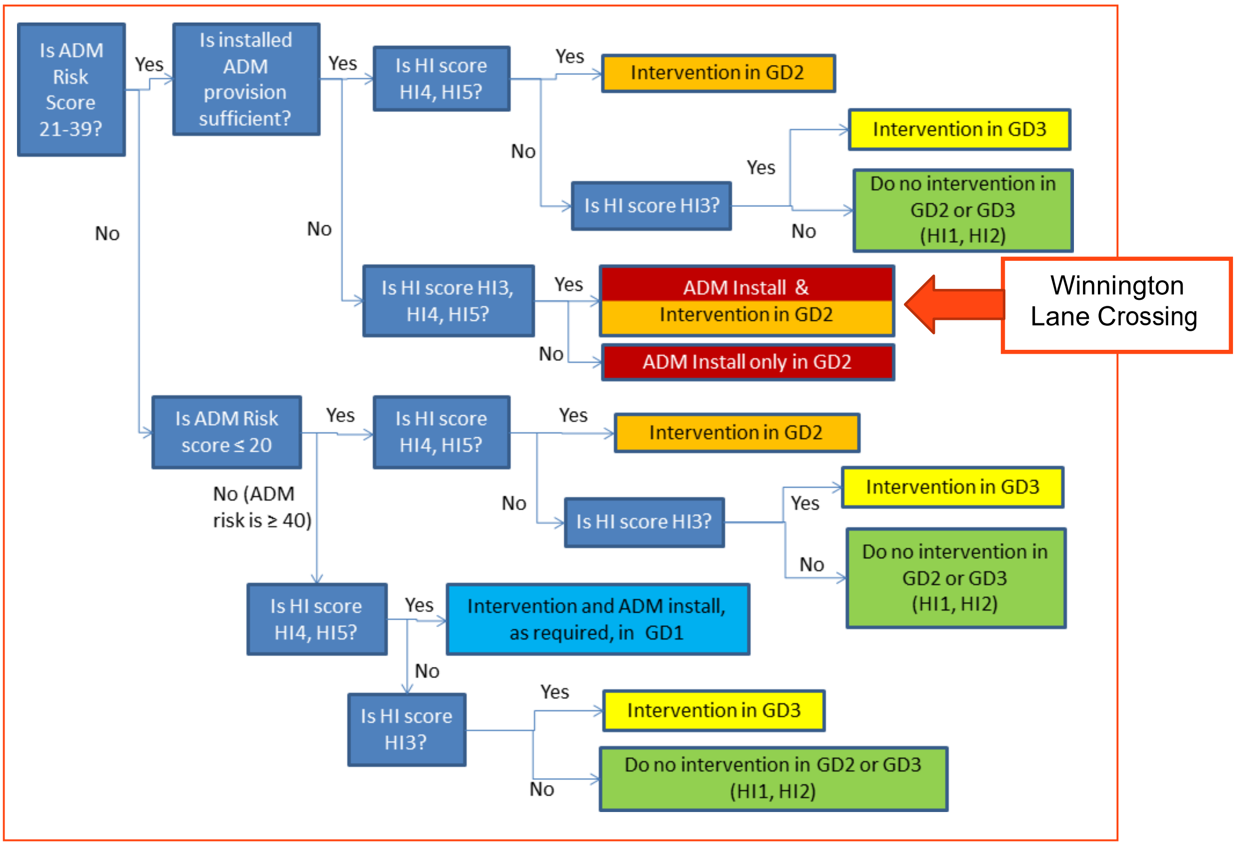

Figure 7: Intervention flow chart for below-7 bar crossings

The preferred option of diversion will address this crossing's ADM score, either by installation of up-to-date ADM on a new pipe bridge or by removing the need for ADM if a directionally-drilled crossing is selected after detailed design and costing.

Appendix 2: Approach and Basis of Calculation for CBA

Our approach to Cost Benefit Analysis

A full Cost Benefit Analysis (CBA) has been undertaken to ensure value for money. Our approach is compliant with HM Treasury's Green Book and the relevant Ofgem guidance. We have followed the Ofgem approach, spreadsheet and societal benefit values and calculations.

Table A1 sets out the options taken into the CBA modelling and the additional CBA scenarios used to test the sensitivity of our results, together with the costs and benefits modelled. To test the sensitivity of the results to Willingness to Pay (WTP) to avoid supply interruptions, we have modelled the diversion both with and without the inclusion of the WTP.

Our approach to CBA has started with the definition of the baseline. Our approach to defining the baseline is the option where we do not invest proactively in our assets, but we do inspect and maintain assets in line with our obligations, and repair assets under a fix on fail strategy. This is the absolute minimum investment we can make in our assets. Other options are then considered which represent increments of investment over and above the baseline.

For this investment area the forecast baseline cannot be fully articulated due to its highly uncertain nature. In these circumstances, the baseline is set at zero and in the options the *changes* in costs are considered — that is, we include the costs of reacting to a failure occurring as avoided costs in each option, rather than as absolute levels of anticipated costs in the baseline.

From a pure CBA point of view the two approaches are equivalent as CBA is all about comparing differences between options.

A summary of the options is shown below. Note: both proactive diversion options have the same Capex estimate so are considered in the CBA as one option. For the purposes of carrying out a CBA we have compared the proactive diversions against the Baseline: Reactive Repair option.

Option in Doc	Option in CBA Template	Costs Used	Benefits Used
Baseline Reactive Repair	Baseline	N/A: Costs of reactive repair are included as benefits (i.e. costs avoided) in relevant Options above	N/A: No activity is being undertaken
Options 1 & 2: Proactive Diversion	Option 1: Diversion	RIIO-2 costs as submitted.	Private and social costs avoided by the option: • Reactive repair • Interruptions to supply WTP • Traffic disruption
	Option 2: CBA Scenario: Diversion without WTP	RIIO-2 costs as submitted.	Private and social costs avoided by the option: • Reactive repair • Traffic disruption
Option 3: Proactive Repair *in situ*	N/A: Option discounted prior to CBA as set out in Section 6.4		

Table A1: Basis of calculations in CBA template

Benefits calculation

The detailed calculations of annual benefits (avoided costs) included in the templates are set out in Table A2.

All avoided costs have been assumed to begin in 2024 and to last for 40 years, in line with the diversion's design life.

Benefits	Approach Used
Reactive Repairs	(Annual chance of reactive repair) x (cost of reactive repair) • We have assumed a failure rate of 1 in 20 years[4], and that • If there were to be a failure, then following emergency repairs a diversion would be installed to provide long-term security of supply. Thus, the cost of reactive repair consists of an assumed XXXX for emergency repairs plus the XXXX diversion cost. The avoided cost of reactive repairs is then: 0.05 x XXXX per year
Interruption to Supply	(Annual chance of interruption to supply) x (number of properties affected) x (WTP to avoid interruption) • We have assumed a failure rate of 1 in 20 years. • The number of properties affected is 2,000. • The WTP to avoid an interruption >24 hours is XXXX The avoided cost of interruption to supply is then: 0.05 x 2,000 x XXXX m per year
Traffic Disruption	(Annual chance of traffic disruption (i.e. failure rate)) x (number of days affected) x (social cost of A-road traffic disruption) • We have assumed a failure rate of 1 in 20 years, and that • The A533 would be disrupted for 15 days due to structural damage. • The average daily social cost of disrupting an 'A' road is XXXX (from Department for Transport data). The avoided cost of traffic disruption is then: 0.05 x 15 x XXXX = XXXX m per year

Table A2: Approach used for calculating avoided costs

[4] This is regarded as conservative, given the HI5 rating of the current crossing.

The CBA Results

Our approach to assessing CBA is as follows:

- For each option, we estimate the Total NPV. This is the discounted sum of costs over time relative to our do-nothing position (the baseline position). In estimating NPV, we have considered costs over five risk categories: financial, environmental, safety, reliability, and other costs.
- All costs are discounted in line with Ofgem's recommended approach; for example, financial impacts are discounted using the Spackman approach.
- A positive NPV means an option reduces the profile of costs relative to the do-nothing (baseline) position and is therefore cost beneficial. The option with the highest positive NPV is the most cost beneficial option.
- Payback shows the year when the sum of costs associated with an option is lower than the baseline i.e. this is the point at which the option can be considered cost beneficial. This is driven by the profile of the costs and the capitalisation rate.

The results in Table A3 show the RIIO-2 proactive expenditure; the ratio of NPV to RIIO-2 spend shows how much NPV per £ spent in RIIO-2 the options generate. A positive figure means the investment is cost beneficial. The higher the figure the most cost beneficial the option is.

Template Option No.	Option Name	Total NPV	Cost Beneficial	Payback Year	RIIO-2 Spend	Ratio NPV to RIIO-2 Spend
Baseline	Baseline	[redacted]	N/A	N/A	[redacted]	
1	Diversion		Cost beneficial	2027		
2	Diversion without WTP		Cost beneficial	2038		

Table A3: Results of CBA for Winnington Lane (£m)

We have not performed separate CBA for each of the two diversion options (pipe bridge or directional drilling) because:

- The benefits of diversion by either option are identical, and
- Given the uncertainties at this stage (Sections 6.2 and 6.3), we cannot meaningfully differentiate the costs of each option.

The decision between directional drilling and building a pipe bridge cannot be made until site surveys have been completed and detailed costings prepared. The choice of Option 1 or Option 2 will be selected when detailed designs have been costed.

Table A3 clearly shows that the option to proactively undertake a diversion is cost beneficial and reaches payback in 2024.

CBA Option 2 tests the sensitivity of this result to WTP to avoid supply interruptions. Removal of these benefits means that it takes longer for the investment to pay back, but it remains cost beneficial.

The high level of positive cost-benefit of the preferred option is demonstrated by the value of 4.5 for its ratio of NPV to RIIO-2 expenditure.

The calculation has been completed using an assumed 1 in 20-year failure rate for the existing crossing, which is likely to be a conservative view given the current HI5 health rating of this crossing.

Tabl A4 shows the drivers underlying these positive results in more detail. In this table:

- Costs are presented as negative values; cost reductions are presented as positive values.
- PV Expenditure and Costs shows the discounted sum of proactive investment (replacement or refurbishment costs) over and above the costs of the baseline. All financial costs are discounted using the Spackman approach.
- PV Environment shows the discounted sum of changes in leakage and shrinkage, using the base case cost of carbon.
- PV Safety shows the discounted sum of the change in the risk of fatalities and injuries, as valued using the Ofgem stated costs per fatality and cost per non-fatal injury.
- PV Reliability shows the discounted sum of the change in interruption risk, as valued using our own valuation research (e.g. the willingness-to-pay study into the cost of interruptions to homes and businesses).
- PV Other shows the discounted sum of any other cost changes, as valued using our research into the cost of property damage and transport disruption.

Template Option No.	Option Name	PV Expenditure & Costs	PV Environment	PV Safety	PV Reliability	PV Other	Total NPV
Baseline	Baseline						
1	Diversion	[redacted]					
2	Diversion without WTP						

Table A4: Breakdown of Winnington Lane CBA results (£m)

Option 1, using all three types of benefit set out in Table A2, shows the proposed diversion to be clearly cost-beneficial with an NPV of XXXX.

The positive NPV result is being driven by three types of benefit (Table A4Tabl). The largest driver of the cost-beneficial results is supply interruptions (shown in the PV Reliability column); however, the proposed diversion remains cost-beneficial even if these are removed from the analysis, as modelled in Option 2.

As can be seen in Table A4, the present value of the costs and expenditure (i.e. RIIO-2 expenditure minus the avoided cost) is marginally negative. Once the avoided costs of traffic disruption (shown in the PV Other column) and supply interruptions that would occur in the event of a failure are included, the benefits of the proactive option are clearly greater than costs. Even excluding WTP to avoid interruptions to supply, and only including the costs of traffic disruption, gives a positive NPV of XXXX.

Therefore, the results of CBA clearly support the preferred option of proactively undertaking a diversion.