national gas transmission

Click here to view the Main Business Plan
Click here to view the published document list

ENGINEERING JUSTIFICATION PAPER (EJP)

OFFICIAL- SENSITIVE

Pipeline Protection

Version: 1.0

Issue: Final

December 2024

RIIO-GT3 NGT_EJP26

Contents

1 Summary Table

Table 1: Pipeline Protection EJP Executive Summary Table

Name of Project	*Pipeline Protection Investments*		
Scheme Reference	*NGT_EJP26_Pipeline Protection_RIIO-GT3*		
Primary Investment Driver	*Legislation and Asset Health*		
Project Initiation Year	*FY27*		
Project Close Out Year	*FY31*		
Total Installed Cost Estimate (£m, 2023/24)	[redacted]		
Cost Estimate Accuracy (%)	+/- 10%		
Project Spend to date (£m, 2023/24)	0		
Current Project Stage Gate	ND500 Stage 4.0		
Reporting Table Ref	6.4 and 6.5		
Outputs included in RIIO-GT3 Business Plan	Asset Health – NARMS Redundant Assets PCD		
Spend Apportionment (£m)	**RIIO-T2**	**RIIO-GT3**	**RIIO-GT4**
	[redacted]	[redacted]	[redacted]

2 Executive Summary

2.1.1 This paper proposes [redacted] of baseline funding to address defects relating to third party activities in the vicinity of the pipeline and its secondary assets population in RIIO-GT3. The spend proposed in this EJP was assessed via NARMS methodology where relevant, some investments fall outside of NARMS.

2.1.2 10,585 interventions are required across buried pipelines, watercourse crossings, marker posts, nitrogen sleeves and TD/1 slabbing to maintain security of supply through our high pressure pipeline network spanning the length and breadth of the UK. Without this investment we are at increased risk from third party interference on our pipes, and consequential loss of containment.

2.1.3 To protect the public from release of high pressure gas, we must operate in accordance with Pressure Systems Safety Regulation (PSSR), Pipeline Safety Regulation (PSR), as set out in this EJP.

2.1.4 We considered 29 intervention types across the pipeline protection portfolio, to establish a programme balancing risk and benefit to the consumer to deliver desired regulatory outputs. We propose the following intervention mix:

Table 2: RIIO-GT3 volumes proposed in this EJP

	Reduced depth of cover (RDOC) Defect	Watercourse crossings defect resolution	Contaminated river crossing remediation	River Exe- Remote Operated Vehicle (ROV) Survey	Nitrogen sleeve remediation	Marker Post Replacement	TD/1 Infringement remediation	Total
RIIO-GT3 volumes	92	33	2	1	455	9,998	**4**	**10,585**

2.1.5 Compared to RIIO-T2, we are asking for an increase of [redacted] RIIO-GT3 due to the following reasons:

- Asset deterioration is driving an increase in nitrogen sleeves work being proposed in RIIO-GT3 to maintain an inert atmosphere at our sleeve population which are located at major road and rail crossings.
- The introduction of TD/1 infringement remediation into this investment decision pack (IDP). This takes the form of slabbing projects at our locations with societal risks higher than ALARP.
- Inclusion of marker post replacements and installation of new marker posts into this IDP to reduce third part risk.

Table 3: RIIO-T2 vs RIIO-GT3 (£m, 2023/24)

	RIIO-T2 Business Plan	RIIO-T2 Forecast Delivery	RIIO-GT3 Business Plan
Interventions	507	186	10,585
Investment	£16.70m	£20m	£47.3m

2.1.6 In RIIO-T2 we are forecasting to deliver fewer reduced depth of cover interventions than planned. This is because we had originally forecast to complete 317 reduced depth of cover interventions using low cost ditch board remediation techniques. However, the defects that arose within RIIO-T2 were more complex than anticipated and required alternative, higher cost methods of remediation to resolve such as topsoil importation which requires landowner consent and landscape redesigning. The deliverability of this work has been assessed and we have high confidence that this portfolio of works can be delivered during RIIO-GT3. The profile of investment for RIIO-GT3 is shown in Table 4.

Table 4: RIIO-GT3 funding request for assets in PIP Programme (£m, 2026/24)

	2026	2027	2028	2029	2030	2031	2032	Total
[redacted]								
[redacted]								
Marker Post Replacement								
Nitrogen Sleeve- Grouting								
Nitrogen sleeve remediation - Minor								
RDOC Defect Mitigation- Fencing and Ditch Board Installation								
RDOC Defect resolution- Topsoil Importation								
[redacted]								
[redacted]								
[redacted]								
[redacted]								
[redacted]								
[redacted]			0.22	0.84	0.06			1.12
Total	**0.87**	**6.49**	**10.16**	**12.01**	**9.09**	**8.28**	**0.46**	**47.3**

3 Introduction

3.1.1 This document outlines our proposed portfolio of works to meet desired regulatory, stakeholder and financial outcomes. The document sets out all investment required to maintain pipeline protection and is divided into 5 sections – Reduced Depth of Cover, Watercourse crossings, Nitrogen Sleeves, Marker Post Replacement, and TD1 Slabbing.

3.1.2 At the time of pipeline construction, Nitrogen sleeves were historically installed at locations such as major road and rail crossings which we would have difficulty gaining maintenance access. They have been superseded by heavy wall pipe. As more nitrogen sleeves are grouted, this reduces the assets we need to monitor and maintain. Marker posts are installed at defined intervals to achieve line of sight and awareness of the asset. BAU Innovation

3.1.3 Pipeline impact protection (PIP) can become necessary at locations where there has been shallowing of the pipeline, factors may include agricultural practices, aeolian erosion, increased surface water and run-off to local water ways. Typically, this is in ditches where they have been cleaned out too deeply, but it can also be in areas where the land has eroded over many years.

3.1.4 Climate change has also brought about extreme weather conditions like high and frequent rainfall which cause surface water flooding in flood-prone areas. This flooding results in washing away of the topsoil and exposes buried pipelines, making them vulnerable to third-party interference.

3.1.5 Reduced depth of cover works may include a combination of compensations to landowners, installation of ditch boards and slabs, reinstation of soil cover or building a protective fence around the affected area. Across difficult to access areas or areas of high consequence, various types of pipeline sleeves are installed for pipeline protection. Finally, for clear visualisation of the below ground presence of a pipeline, Marker Posts are installed to reduce the risk of third-party damage. BAU Innovation

3.1.6 Third-party interference/damage remains one of the biggest risks to the safety and physical integrity of the network, along with corrosion. We are obliged to comply with legislation and standards, including Pipelines Safety Regulations (PSR) and Pressure Systems Safety Regulations (PSSR). More information on these legislations can be found in here.

3.1.7 In addition to the capital investments into impact protection, additional operational expenditure is also directed toward liaison (letters and face-to-face meetings) with land users and working with them to ensure that their activities do not pose a risk to the pipelines laid under their land. This may also include restrictive legal covenants and land purchase and demarcation. These are covered in the OPEX plan.

3.1.8 The worklist in this EJP has been generated by creating forecasted run-rates of work expected based on utilising current and historic defect data held in our core systems, along with data held on watercourse crossings and the riverbank characteristics. Due to the majority of interventions being on the secondary asset such as land cover above a pipeline, we do not have condition data or grade for the land as it is not an asset that belongs to NGT.

3.1.9 The scope of this document is aligned with our Asset Management System (AMS) and relates to our Legislative Compliance, Asset Health and Stable Network Risk Business Plan Commitments (BPCs). More information on our AMS and a description of our commitments is provided in our **NGT_A08_Network Asset Management Strategy_RIIO_GT3 annex** and our BPCs are detailed within our **Main Business Plan.**

Document structure

3.1.10 This EJP has been structured as shown in Figure 1 below to cover three sub-themes of PIP Programme, each with their independent problem statements:

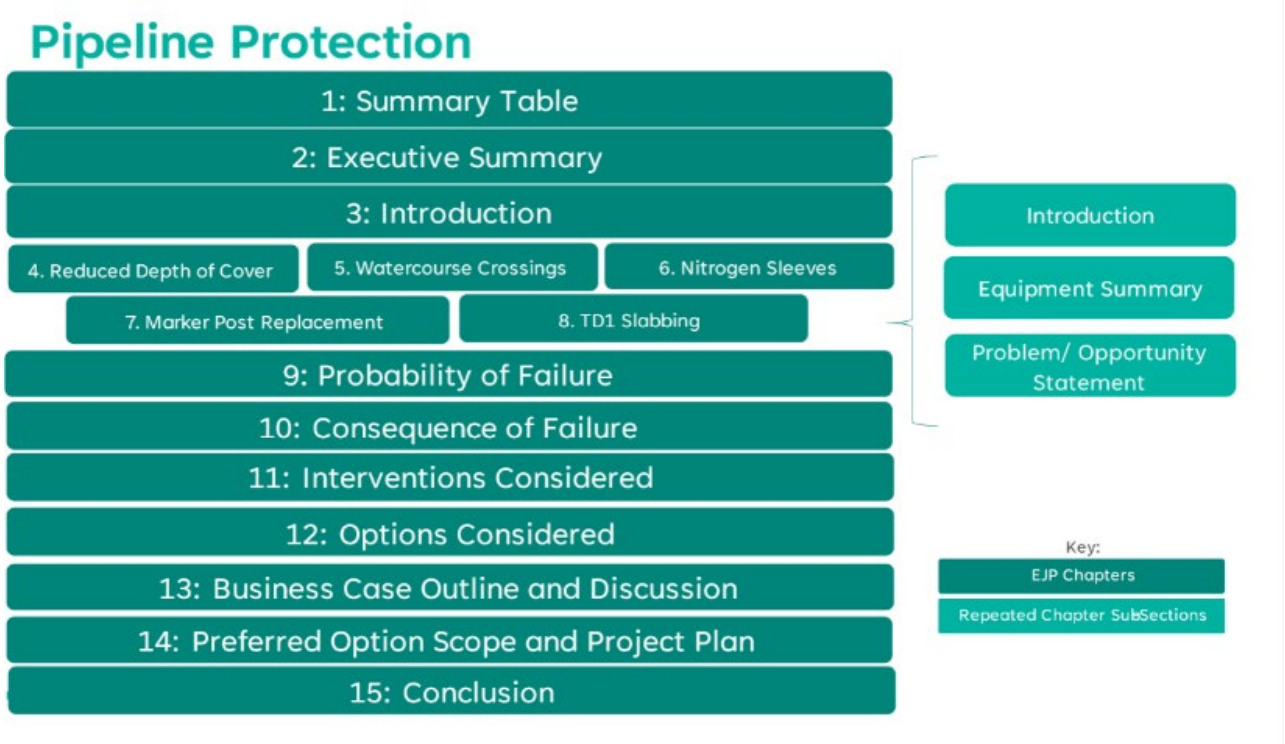


Figure 1: Structure of this EJP

3.1.11 This EJP interacts with the NGT_EJP26_Pipeline Protection_RIIO-GT3 which presents other interventions proposed on our pipeline assets.

4 Reduced Depth of Cover – [redacted]

4.1 Introduction

4.1.1 This chapter of the EJP provides justification for our Reduced Depth of Cover (RDoC) investments of the buried pipeline in rural and suburban areas. Investments for our watercourse crossings assets are covered in the **Watercourse Crossings Chapter**.

4.1.2 The depth of ground cover above the pipeline is essential for managing the risk of damage to the pipeline by third parties and thereby enabling our compliance with PSR 1996 Regulation 9. More information on this legislation is in Appendix 2.

4.2 Equipment Summary

4.2.1 The relevant asset to this needs case is our buried pipelines which are covered in the Pipeline EJP equipment summary.

4.2.2 The pipelines in the NTS are constructed and operated in accordance with the recommendations of the Institution of Gas Engineers and Managers (IGEM) standard IGEM/TD/1. This Standard sets requirements for the minimum depth of cover over pipelines, which are dependent on the pipeline location.

4.2.3 Depth of cover above pipelines are measured during cyclic line walking.

4.2.4 NTS Pipelines generally operate at a maximum operating pressure (MOP)[redacted].

4.2.5 A summary of the minimum depth of cover requirements for pipelines specified in IGEM/TD/1 can be found in Appendix 2.

4.2.6 Additional information on this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying **NGT_IDP11_Portfolio EJP Pipeline Protection_RIIO-GT3.**

4.3 Problem Statement

Why are we doing this work and what happens if we do nothing?

4.3.1 The key drivers for investments are summarised in Table 5, below.

Table 5: Investment drivers for RDoC defects on buried pipelines

Driver Category	Description
Legislation	Compliance with Pipeline Safety Regulations legislation to protect members of the public.
Erosion of cover above the Pipeline	Over time the level of cover over the pipeline may erode due to several factors. Without sufficient cover, the pipelines are susceptible to damage from third party interference. Moreover, increase in temperature and reductions in rainfall, change in farming practices, intensity of farming, using bigger machinery and re-profiling the landscape may all result in shrinkage of clay and organic soils, resulting in reduced cover for pipes. The shrinkage and associated drying of soils also make it vulnerable to wind and water driven erosion.

4.3.2 PSR legislation requires us to manage the risk of damage to our high pressure (HP) pipelines. If we do nothing to manage our pipeline assets, we will be unable to operate in accordance with our license obligations. Damage to a buried HP pipeline is a risk to operatives' and the public's safety and a loss of containment event would be difficult to restore containment.

4.3.3 Reduced depth of cover above our buried Pipeline assets presents a risk to the pipeline's structural integrity and any associated potential safety and environmental implications.

4.3.4 If we do nothing on reduced cover defects, depth of cover will continue to deteriorate and present an increasing risk of damage to the Pipeline by either third parties or lack of structural support. Either of these could lead to the loss of containment of high-pressure gas and the associated impact on public safety, the environment, and the effective operation of the NTS, resulting in a potential loss of supply and consequential disruption to consumers and customers.

What is the outcome that we want to achieve?

4.3.5 Within RIIO-GT3, the outcome we want to achieve is continued compliance with legislation to enable continued operation of pipeline assets and security of supply.

How will we understand if the spend has been successful?

4.3.6 The investment proposal will have been successful if all pipelines remain compliant with legislation and are buried with the minimum depth of cover.

Narrative real life example of problem

4.3.7 The image below, Figure 2, is an example of DOC of pipeline generated from In-line inspection (ILI) mapping, comparing ILI tool positioning data to Lidar sensor data to determine pipeline depth of burial. This highlights areas where the pipeline coverage is either sufficient, which is marked in green, or does not comply with the recognised standard IGEM/TD/1, which is marked in red, or in orange where the coverage is approaching being insufficient. We would risk assess these locations based on factors such as land usage to determine intervention requirements.

Project Boundaries

4.3.8 The work associated with these investments solely mitigate or remediate issues with reduced depth of cover above buried pipelines identified. They do not address issues on the pipeline assets.

5 Watercourse Crossings [redacted]

5.1 Introduction

5.1.1 This chapter presents the problem statement associated with watercourse crossings which include reduced depth of cover, redundancy, and inspection.

5.1.2 Watercourse crossings on the NTS are surveyed at regular intervals to monitor the depth of cover over the pipeline at the various crossing locations. Where reduced depth of cover defects are raised, an annual review process takes place during which the severity and implication of the RDOC at these crossings is assessed.

5.2 Equipment Summary

5.2.1 A watercourse crossing is defined as a location where a pipeline has been constructed in the bed of a watercourse which may include streams, rivers, navigable waterways, estuaries, large expanses of water, shore approaches and other shallow waters affected by adverse water and associated ground conditions.

[redacted]

5.2.2 The depth of ground cover and riverbed cover above the pipeline are essential in managing the risk of damage to the pipeline by third parties and erosion under the pipeline from water flow.

5.2.3 As per IGEM/TD/1, the minimum depth of cover requirement for pipelines within water courses constructed up to and during 1984 is 0.9m and for pipelines constructed during or after 1985 is 1.1m.

5.2.4 The depth of cover above a pipeline is recorded during a combination of cycling line walking and Watercourse crossing surveys.

5.2.5 Additional information on this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying **NGT_IDP11_Portfolio EJP Pipeline Protection_RIIO-GT3**.

Location and Volume

5.2.6 The classification of the crossing is used to facilitate understanding of the environment and how that pipeline needs to be surveyed and maintained.

5.2.7 We have a total of [redacted] The watercourse crossings listed as 'other' generally take the form of stream crossings and are of narrow width. These are typically managed via line walking to inspect them.

Pressure Ratings

5.2.8 The depth of ground cover and riverbed cover at water crossings protect the NTS Pipeline which operates up to a maximum operating pressure [redacted]

5.2.9 A survey is undertaken on a 6 yearly basis of all river crossing points, navigable water courses, estuaries, large expanses of water and other locations affected by adverse water and associated ground conditions to establish the following:

- The depth and profile of the pipeline within the limits of the crossing
- The profile of the bed and banks
- The condition of the pipelines within the river crossings
- The construction and condition of the bed and banks
- The pipeline has adequate cathodic protection in accordance with [redacted]

5.2.10 This survey identifies any remedial activities that need to be undertaken to protect the pipeline from mechanical damage.

Decommissioning Pipeline

5.2.11 Decommissioning and abandonment are addressed in several standards, Acts of Parliament, regulations, and company documents, often using differing terminology.

The definitions of these terminology set out by UKOPA in the document - *Good Practise Guide for Pipeline Decommissioning and Abandonment dated July 2023* can be found in Appendix 3.

Pipelines Installed in Tunnels

5.2.12 Inspection and assessment of results for pipelines installed in tunnels suitable for internal inspection shall be in accordance with internal policy.

5.2.13 Monitoring and maintenance of the CP system of a pipeline in a tunnel shall be undertaken in accordance with internal policy.

5.2.14 In the unlikely event of any adverse indications such as visible settlement, failures of the CP system or chemistry of the tunnel fill material that could lead to early deterioration of the concrete tunnel lining or reinforcement, further specialist investigation may be required.

5.3 Problem Statement

Why are we doing this work and what happens if we do nothing?

5.3.1 This paper addresses 3 key issues across our watercourse crossings as follow:

- Reduced depth of cover on watercourse crossings
- Redundant Watercourse Crossings
- [redacted]

Reduced Depth of Cover on Watercourse Crossings

5.3.2 Over time the level of cover over the pipeline may erode. Without sufficient cover, the pipelines may be susceptible to additional loading from the flow of water, potential damage from third party interference or impact damage from marine traffic. For the major crossings, the risk is from anchor drag on the large shipping vessels. For minor crossings, the risk is exposure or a potential strike from an excavator (or dredge) clearing the riverbed and banks.

5.3.3 Flash flooding events from intense rainfall can cause erosion by breaking down and dispersing soil particles. The resultant effect is the RDoC over our buried pipeline assets. With predicted climate change induced increased temperatures resulting in warmer air holding more water, the amount of rainfall is expected to increase. The rate of erosion, from flash flood events, is therefore expected to be accelerated by climate change impacts.

5.3.4 Events like this are expected to become more frequent due to climate change. According to the EU Science Hub it is predicted that intense rainfall could wash away 13-23% of EU and UK agri-soils by 2050.

5.3.5 Where pipelines are laid across rivers or estuaries within or on the bed material there is a risk that tidal scouring can lead to the pipeline becoming exposed. Once the crown of the pipe is exposed interaction between the tidal flow and the pipe can cause vortices which remove bed material resulting in the pipeline being unsupported by any riverbed material. This is referred to as the pipeline spanning the river crossing.

5.3.6 Over time, this spanning can result in the mechanical deformation of the pipeline under its own weight and tidal action can lead to rupture. Spanning can also result from flash flooding or river wandering typically leading to exposure of the pipe at the riverbank where it drops to pass under the river.

5.3.7 If we do nothing on reduced cover on watercourse crossings, cover will continue to deteriorate and present an increasing risk of damage to the pipeline by either third parties or lack of structural support. Either of these could lead to the loss of containment of high-pressure gas and the associated impact on public safety, the environment, and the effective operation of the NTS.

5.3.8 Known RDoC defects:

- There are [redacted] locations where the level of cover above or support below the pipeline in a watercourse crossing has been eroded and presents an increased risk of damage to the pipeline. These present a risk to its structural integrity and any associated potential safety and environmental implications.
- All locations have been risk assessed and need continual monitoring and remediation works in RIIO-GT3 and the following regulatory period.

5.3.9 The locations of these RDoC defects on watercourse crossings are summarised in Table 6, below:

Table 6: Open defects of RDoC on watercourse crossings

Feeder	Item	Failure Mode Description
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Redundant Watercourse Crossings

5.3.10 The block valves on either side of [redacted] River Crossing are redundant and cocooned, and [redacted] River Crossing no longer has operational requirement. The asset is therefore redundant.

5.3.11 [redacted] is a buried block valve site located on the [redacted] The site consists of three block valves contained within separate buried valve pit structures. This redundant feeder section has been abandoned and nitrogen filled.

5.3.12 [redacted] The site consists of three block valves contained within separate buried valve pit structures, each of which is contained within a separate wooden post and rail fence.

5.3.13 Both duplicate crossings at [redacted] were installed for construction back in 1970s to enable maintenance of one crossing whilst being able to continue to transport gas through the other.

5.3.14 It is important to decommission such assets now to remove the remaining risk to the NTS and the environment. Delaying this investment increases cost to future consumers which saw no benefit from the assets.

[redacted]

5.3.15 [redacted] pipeline section located [redacted]

[redacted]

[redacted]

5.3.16 Due to the dimensions and designs of the structure, we have not been able to carry out internal inspection with an existing Pipe Inspection Vehicle (PIV) like we do with other watercourse crossings to determine the indicative condition of the asset. We therefore require a specialist solution to examine this structure.

5.3.17 This structure was installed in 2008 and has not been inspected since. We intend to examine the condition of the structure and the pipeline hangers anchoring the pipeline to the structure.

5.3.18 If we do not undertake the condition assessment now, the asset condition will continue to be unknown to us and this will pose significant risks environmentally, financially, safety-related, and societally discussed in Chapter 10.

What is the outcome that we want to achieve?

5.3.19 Within RIIO-GT3, the outcome NGT want to achieve is continued compliance with legislation to enable continued operation of pipeline assets.

5.3.20 We want to balance the risks and costs associated with managing redundant watercourse crossings that will not bring benefits to our consumers in the future.

5.3.21 Undertake internal inspection, monitoring and maintenance of the CP system of a pipeline in a tunnel in accordance with the requirements of National Gas Internal Maintenance Policies.

How will we understand if the spend has been successful.

5.3.22 The spend will have been successful if all pipelines remain compliant and are buried under minimum depth of cover.

5.3.23 We can undertake internal inspection of [redacted] to increase our knowledge of the asset's condition and identify any intervention requirements.

Narrative real life example of problem

5.3.24 [redacted], three 1-in-200 floods occurred in the past 5 years. In the most recent event, in Autumn 2023, pipe crossings, gabions and farmlands were washed away. The pipeline asset was still able to be used but was floating on the riverbed leaving it vulnerable to mechanical damage. As a response, NG reinstated the riverbank over the pipe and on the south side by using rock bags as shown in the pictures below (Figure 6).

Figure 6 (left) Rock bags to reinstate DOC [redacted]

Project Boundaries

5.3.25 The project boundaries for this portfolio of work involve works to the riverbed and adjacent land only. They do not include works to the pipeline asset itself.

6 Nitrogen Sleeves - [redacted]

6.1 Introduction

6.1.1 This section of the EJP presents the investment case for Nitrogen Sleeves. There are around 2,000 pipeline protection sleeves installed around the NTS to mitigate the risk of a pipeline failure at a specific location.

6.1.2 Pipeline protection sleeves consist of a casing installed around the pipeline at the time of construction to protect the pipeline from external interference. They are typically located at significant road crossings, railways or near to housing/ populated areas.

6.1.3 There are 3 classes of pipeline protection sleeves. Some are filled with nitrogen to provide an inert atmosphere to prevent corrosion from taking place to both the sleeve and pipeline and should maintain positive nitrogen pressure within the annulus for a minimum period of 12 months. Over time, deterioration of the asset leads to loss of containment of the Nitrogen fill.

6.2 Equipment Summary

6.2.1 The sleeves are fitted around or in proximity to the NTS Pipelines which operate up to a maximum operating pressure of between [redacted]

6.2.2 These are assessed cyclically to identify whether they continue to maintain an inert atmosphere.

6.2.3 The photo below, Figure 7, shows a mock-up of a nitrogen sleeve as part of a test for an alternative pipe/sleeve annulus fill:

Figure 7: A nitrogen sleeve

6.2.4 All nitrogen filled sleeves are cathodically protected to prevent loss of nitrogen through corrosion damage. The CP of nitrogen filled sleeves is provided by the pipeline protection system by virtue of forged/welded end seals, or by the use of a direct cable bond between the sleeve and carrier pipe where non-welded end seals (e.g. epoxy end seals) are in place.

6.2.5 Further information about the three types of sleeves can be found in Appendix 4.

6.2.6 Additional information on this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying NGT_IDP11_Portfolio EJP Pipeline Protection_RIIO-GT3

6.3 Problem Statement

Why are we doing this work and what happens if we do nothing?

6.3.1 The key driver for pipeline protection sleeves investments is asset deterioration.

6.3.2 We routinely monitor the pressure of installed nitrogen sleeves across the network and have found that a number are in unsatisfactory condition and interventions are required to reinstate the functionality of the sleeves.

6.3.3 Class 1 Nitrogen sleeves' service/test components deteriorate due to corrosion and wear at the seal ends or valve top-up line connections, allowing the sleeve to depressurise, nitrogen gas to escape, and water to ingress into the annular gap, causing concentrated corrosion on the pipeline.

6.3.4 Where the sleeve can be shown to hold nitrogen pressure over a reduced interval, it is necessary to review the costs associated with frequent recharging against the costs associated with investigating and undertaking repair work required for reinstating 12 month charge capability.

6.3.5 Lack of investment in the Nitrogen sleeves now directly results in the inability of the sleeve to contain Nitrogen at the specified pressure of 1 bar. This has a direct result of leakage of the nitrogen to atmosphere and the ability for water to ingress. The water causes the corrosion of the pipeline, reducing its structural integrity and ultimately reducing its fitness for purpose.

6.3.6 Given the location of Nitrogen sleeves being under Major Road crossings and sensitive locations such as railway lines it is imperative that the inert environment is maintained to ensure pipeline corrosion is prevented.

What is the outcome that we want to achieve?

6.3.7 All nitrogen sleeves intervened upon retain/ regain their ability to seal completely to prevent gas leak and subsequent water ingress.

6.3.8 We would like to ensure that all sleeves maintain an inert environment to prevent corrosion on the pipeline at sensitive locations.

How will we understand if the spend has been successful?

6.3.9 All nitrogen sleeves fully functional with all known condition and safety issues resolved. All assets are compliant with key legislation such as PSSR and do not loose pressure between surveys.

6.3.10 We would like to continue and expand our Nitrogen Sleeve grout filling programme. This eliminates the future need for topping up of nitrogen and subsequent interventions by creating a permanent inert environment.

Narrative Real Life Example of Problem

6.3.11 Nitrogen sleeves wear over time at their end seals which affects the ability to contain nitrogen. The below image, Figure 8, shows a defective end seal on a sleeve at [redacted]

Figure 8: Defective Nitrogen Sleeve End Seal

6.3.12 Nitrogen sleeves are surveyed on a cyclic basis to monitor, top up with additional nitrogen where required and identify intervention requirements. A selection of these survey results is provided in Table 7 below:

Table 7: Nitrogen Sleeve Survey Results

Grid reference	Activity Description	Location	Sleeve Pressure Reading (Millibar- mb)	Status
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Project Boundaries

6.3.13 The work associated with these investments solely address issues with Nitrogen sleeves. They do not address issues on the pipeline assets. There is no investment proposed in any of the other sleeve types within this investment case.

7 Marker Post Replacement - [redacted]

7.1 Introduction

7.1.1 This chapter of the EJP details the routine replacement of faulty or damaged Marker Posts and installation of additional ones where required to ensure the safety, integrity, and reliable operation of our buried transmission pipelines.

7.1.2 Marker Posts highlight the presence of NGT assets as they cross third party land. They reduce third party risks such as strikes by increasing the visibility of pipeline routes.

7.2 Equipment Summary

7.2.1 Marker Posts' prime purpose is to identify the presence and location of our pipeline to minimise third party damage. Vegetation growth is an ongoing asset management challenge which makes marker posts all the more important to aid in location of our pipelines.

7.2.2 Relevant legislation and standard to Marker Posts are IGEM/TD/1 and PSR. More details, can be found in Appendix 5.

7.2.3 Additional information on this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying **NGT_IDP11_Portfolio EJP Pipeline Protection_RIIO-GT3**.

7.2.4 Locations of Marker Posts include the following:

- Route of a pipeline through a road, rail, or other crossing
- Position of a pipeline entering an Above Ground Installation (AGI)
- Field boundaries
- Crossing points, such as railways, roads, motorways, waterways, etc.
- Land boundaries in urban areas

7.2.5 There are three types of Marker Posts we currently use including Aerial Marker Posts, M4 Marker Posts and M28 Cathodic Protection Marker Posts.

7.3 Problem Statement

Why are we doing this work and what happens if we do nothing?

7.3.1 The key driver for Marker Post replacement investments is PSR legislation.

7.3.2 In 2019, HSE carried out random inspections of above ground associated equipment on the NTS and identified several instances of poorly maintained equipment associated with pipelines that should have been identified when line walking, reported and rectified. As a result of the findings, HSE issued an Action Legal around ensuring we have sufficient posts at adequate spacing where they are required. This Action Legal was closed in 2021.

7.3.3 There is a replacement need for existing marker posts as they fail over the plan period and for the installation of additional marker posts where deemed appropriate to provide additional risk mitigation. Continued investment across the network is required to maintain pipeline visibility, reducing accidental damage to our pipeline assets and to avoid further intervention from the HSE on the items highlighted during the 2019 inspection. Marker posts are exposed to external damage and weathering. M4 Marker Posts and M28 CP Test Posts are particularly susceptible to damage from agricultural machinery such as verge and flail mowers.

What is the outcome that we want to achieve?

7.3.4 Maintain safe marking of our pipelines to reduce the likelihood of accidental damage, by maintaining and installing functional Marker Posts according to policy.

How will we understand if the spend has been successful?

7.3.5 All defective Marker Posts replaced with new Marker Posts and new Marker Posts installed in locations where assets were previously missing.

Narrative real life example of problem

7.3.6 In 2019, HSE carried out random inspections of above ground associated equipment on our NTS at road crossings and along Pipeline easements. This identified several instances of poorly maintained equipment or locations which had insufficient line of sight between marker posts.

7.3.7 An example was a [redacted] at which no marker posts were present and the face plate of a Cathodic Protection (CP) post which had faded to the degree that it had become illegible.

7.3.8 As a result of the findings, HSE issued an Action Legal around ensuring we have sufficient posts at adequate spacing where they are required. In response to that, NG identified 11,678 road crossings within a two-year programme and surveyed all pipeline markers at road crossings. All compliance issues identified through these surveys had been recorded in the defect management system. Action Legal letters attached in Appendix 6.

Project Boundaries

7.3.9 The work associated with these investments solely address issues with Marker Posts. They do not address issues on the pipeline assets.

7.3.10 This is for the replacement of existing markers posts with the installation of a like-for-like post or the installation of a new marker post where required.

7.3.11 It does not cover the retrofitting of technology into existing marker posts.

8 TD/1 Slabbing- [redacted]

8.1 Introduction

8.1.1 We adopt IGEM/TD/1 Edition 6 for compliance in the construction, operation and maintenance of onshore steel pipelines used for the large-scale transmission of natural gas. An infringement of this policy (known as a "TD/1 infringement") occurs where buildings or occupation zones are too close to the pipeline and requires physical interventions to achieve an As Low As is Reasonably Practicable ("ALARP") risk to the pipeline and the public.

8.1.2 We undertake four-yearly audits of our high-pressure pipeline system to assess compliance with the IGEM/TD/1 Standard and identify IGEM/TD/1 infringements. The four-yearly audits also identify any populations that exceed the allowable limits as defined in TD/1 for the pipeline. They are then subject to risk screening in accordance with the screening methodology, and full site-specific risk assessment if appropriate, in accordance with the National Gas Hazard Assessment Methodology Manual (HAMM).

8.1.3 In all the locations below, the pipeline was installed prior to the developments being built. These infringements generally occur over time caused by a lack of consultation from developers and local authorities with NGT prior to granting planning consent. This can also occur due to piecemeal development which slowly encroaches over the proximity distance limits without consultation with NGT.

8.1.4 The responsibility for determining the acceptability of new proposed developments in the vicinity of high pressure pipelines is the statutory responsibility of the Local Authority.

8.1.5 When we are not notified, these infringements are only picked up when work starts on site which doesn't allow for any mitigation to be designed and installed as part of the development works. This results in developments being constructed near pipeline routes without any mitigation being provided resulting in a risk to the population.

8.2 Equipment Summary

8.2.1 For the four locations within this EJP, aerial images have been provided along with the details of the population present. The definitions of the labels shown below is located here.

8.2.2 Additional information on this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying **NGT_IDP11_Portfolio EJP Pipeline Protection_RIIO-GT3**.

Location 1: [redacted]

8.2.3 This location encompasses National Gas AGI and is surrounded by a mix of small businesses, housing, and a hotel.

[redacted]

Location 2 [redacted]

8.2.4 This location includes [redacted] where existing heavy wall pipe is present. There are small businesses and a large residential population to the East and West of the pipeline.


[redacted]

Location 3: [redacted]

8.2.5 This location includes a holiday caravan site that is situated on the pipeline surrounded by open farmland.


[redacted]

Location 4: [redacted]

8.2.6 This location includes a medium size residential area either side of the pipeline. On the east side of the pipeline is [redacted] This is considered a [redacted]

[redacted]

8.3 Problem Statement

Why are we doing this work and what happens if we do nothing?

8.3.1 The societal risk caused by the presence of NGT's pipelines at the locations described above cannot be demonstrated to be ALARP. It poses an unacceptable level of risk to the public which needs to be brought into line with safety regulations.

8.3.2 Under regulation 23 of the Pipelines Safety Regulations (PSR), we are required to evaluate the risks of hazards that may cause a major accident and demonstrate that an adequate safety management system is in place. We comply with this requirement by adhering IGEM/TD/1 and TD/2.

8.3.3 Under the Gas Safety (Management) Regulations (GSMR) 1996, we are required to produce a safety case demonstrating the risks of operating the NTS which shall also demonstrate that the risks to the public are ALARP.

8.3.4 Under IGEM/TD/1 Edition 6, section 12 and section 6 we are required to assess changes in population within the pipeline corridor. This is to ensure that risk presented to the public by the pipeline remains tolerable and in line with the expected risk levels as defined in IGEM/TD/2 Edition 2, section 6. If the risks are shown to lie outside this tolerable region, then an ALARP demonstration is required to determine if risk reduction measures are required.

What is the outcome that we want to achieve?

8.3.5 Under the obligations described above we must take actions to reduce the risk to a level that can be shown to be ALARP.

How will we understand if the spend has been successful?

8.3.6 Risk to the pipeline and the public in these locations are considered ALARP according to TD/1 and TD/2 policies.

Narrative real life example of problem

8.3.7 Four real life examples of this problem statement presented above.

Project Boundaries

8.3.8 This investment only mitigates risks that may cause a major accident within the boundaries of the locations. It does not address issues of other aspects found in those locations.

9 Probability of Failure

9.1.1 Due to this EJP being based on secondary asset classes such as land cover, we do not have forecasted probability of failure data as we do not record the land cover as assets. We have provided a combination of historic defect information and survey information to populate this section.

9.2 Reduced Depth of Cover

9.2.1 Table 8 below summarises the total number of RDoC defects raised on buried pipelines in rural and suburban areas each year from 2013 to 2020 on our asset data system, Maximo. On average, 154 defects were raised each year.

Table 8 DOC defects on buried pipeline onshore raised from 2013 to 2020.

Year defect raised	Count of defects raised
2013	6
2015	11
2017	13
2018	666
2019	31
2020	198
Total	**925**

9.2.2 Since the start of RIIO-T2, we have been using LiDAR technology in our ILI inspections to assess the depth of cover of our pipelines. An example of a Depth of Cover Summary Report produced by external consultants [redacted] can be found in Appendix 7.

9.2.3 Failure modes associated with this would be pipeline rupture from third party activities.

9.2.4 Out of the 17 pipeline sections using LiDAR data gathered in 2021-2022 ILI inspections (a total of 634km), 2,763 occurrences of RDOC were identified along a total of 26km of pipeline. Table 9 summarises instances of RDOC occurrences found during these inspections.

Table 9 Depth of cover occurrences found in ILI inspections in 2021-2022

Depth Of Cover (m)	Count of occurrences	Total length (km)
</= 0.6	268	1.75
>0.6 and </= 1.1	2495	24.37
Total	**2763**	**26.12**

9.3 Watercourse Crossings

9.3.1 Table 10 below summarises the total number of RDOC defects raised on watercourse crossings each year from 2019 to 2023. On average, 16 defects were raised each year.

9.3.2 Failure modes associated with this would be pipeline rupture from third party damage such as boats or mechanical failure of the pipeline due to water current being applied to an unsupported pipeline.

Table 10 Reduced depth of cover defects on watercourse crossings from 2019 to 2023.

Year defect raised	Count of defect raised
2019	1
2020	28
2021	29
2022	21
2023	2
Total	**81**

9.4 Nitrogen sleeves

9.4.1 Out of a total population of [redacted], we have identified that 359 Sleeves are losing pressure between annual inspection and require refurbishment to enable containment of nitrogen. Additionally, 182 sleeves are losing pressure between annual inspections and have other defects which we propose to permanently resolve via grout filling.

9.4.2 The failure mode associated with this is failure of the sleeve to contain nitrogen. This would result in corrosion of the pipeline. Due to the location of these sleeves, we cannot have corrosion growth due to the inaccessibility of the pipeline to conduct repairs.

Table 11 Open defects on nitrogen sleeve on Maximo

Defect	Open Defect counts	% of Sleeves
Nitrogen Sleeve- Grouting	182	[redacted]
Nitrogen Sleeve remediation- minor	359	

9.4.3 The probability of failure is based on the existing defect run rate. We inspect all sleeves every year and find a total defect rate of [redacted] The work list proposed within this EJP is based on this rate.

9.5 TD/1 Slabbing

9.5.1 The HAMM methodology (T/SP/HAZ/16) used by NGT considers the probability of failure from both third-party damage and a pipeline example is shown in the below Table 12. The frequencies used for each of these failure types is determined using industry data gathered by various industry bodies such as United Kingdom Onshore Pipeline Association and EGIG. This is then included within the Pipesafe software models.

9.5.2 The risk of third party damage resulting in failure changes based upon the existing land use and pipeline wall thickness. The below table shows that the highest risk location is a pipeline with a low pipe wall thickness which is in a Type S area.

9.5.3 A Type R area is rural areas with a population density not exceeding 2.5 persons per hectare.

9.5.4 A Type S area is an area which has been developed with residential properties, shops, schools etc, where the population density is greater than 2.5 persons per hectare and less than 30 persons per hectare.

9.5.5 Areas with higher population densities per hectare are referred to as Type H and Type T areas.

Table 12 HAMM methodology used for assessing probability of failure by third party and ground movement.

Failure cause	Diameter (mm)	MOP (barg)	Wall thickness (mm)	Grade	Area type	Rupture frequency probability per million km years
Third Party Activity	600	75	17.48		S	0.1684
			17.48		R	0.291
			9.52		R	20.719
			9.52		S	71.407

9.5.6 Within the UK the risk to pipelines is dominated by potential third-party damage (usually accidental), therefore the process for assessing and resolving infringements focuses the application of measures to reduce the risk of this occurring.

Probability of Failure Data Assurance

9.5.7 We have high confidence in the data provided within the probability of failure section. It is gathered during routine cyclic line walking and surveys.

9.5.8 The methodology used for assessing probability of third-party damage and ground movement are consistent with those used by other pipeline operators within the PSG Pipesafe group and are widely accepted as recommended practise for managing third party risk within the industry.

10 Consequence of Failure

10.1.1 The contribution of individual service risk measures towards the overall risk for our pipeline assets due to failures of Marker Posts and Nitrogen Sleeves, as well as reduced depth of cover of our buried pipelines on shore and underwater, can be explained as follows, in order of significance left to right:

Table 13 Consequences of pipeline assets presented in this EJP failing across NARMS service risk measures.

Impact / Consequence				
Environmental	**Safety**	**Availability**	**Financial**	**Societal**
The loss of gas arising from a leak or rupture of the pipeline caused by external interference	Increased risk of an external interference event with a low depth of pipeline cover resulting in risk of third party damage and, consequential risk to the public or our operatives. Where the pipeline passes near centres of population the safety risk arising from ignition of the leak or rupture is increased. Nitrogen sleeves also provide additional protection against pipe wall corrosion. The risk of an external interference event is much more likely without the protection against impact afforded by slabs and sleeves. Increased interactions with the HSE with the potential for improvement notices.	The potential outages associated with the shut-down of a pipeline for repair of a leak or rupture caused by external interference, impacting downstream customers with a potential for a loss of supply to consumers.	Mostly associated with the costs of operating and maintaining the network at the current level of risk Also, the associated cost for Unaccounted for Gas (UAG) which has a consumer cost impact from a leak or rupture of the pipeline.	Disruption to road or rail transportation following asset failure. Likelihood of a fire or explosion is small

11 Interventions Considered

11.1.1 The interventions in this EJP have been developed to address the various issues articulated in the problem statements in Chapters 4 to 8. More information on these interventions is provided here.

11.2 Reduced depth of cover interventions

Counterfactual (Do Nothing)

11.2.1 This intervention involves undertaking no capital investment to address reduced depth of cover on our buried pipelines in dry land.

11.2.2 We may proceed with other non-asset BAU interventions such as advice to the landowner.

11.2.3 This is not acceptable as a solution for defects identified as the consequence of not remediating/resolving a RDOC defect would be significant.

Defect Mitigation (Fencing and Ditchboard Installation)

11.2.4 This intervention involves immediate mitigation to highlight the presence of RDOC defect and prevent third party activities such as agricultural/drainage or other works above the pipeline. The possible solutions vary from site to site, depending on the specific characteristic of the location of the defect:

- Fencing - fencing off the affected area
- Ditchboard installation - covering the affected area in a ditch with a ditchboard.

11.2.5 No outage or pressure reduction is required for this intervention.

Defect resolution (Topsoil importation)

11.2.6 This intervention involves replacing cover on the pipeline in affected area by purchasing additional topsoil and adding it to the top of the pipeline.

Remove and re-lay affected section of the pipeline.

11.2.7 This intervention involves removing a section and re-laying in a deeper trench.

Diversion

11.2.8 Laying a new section of Pipeline along an alternative route and stop gas flowing down the pipeline section with RDoC defect to avoid the issues at the current location.

Intervention Summary

11.2.9 Table 14 summarises all investments considered for RDOC over buried pipelines.

Table 14 Interventions considered for Reduced Depth of Cover

Intervention	Pros	Cons	Taken forward
Counterfactual (Do Nothing)	There is no CAPEX investment required for RDoC defect.	Intervention does not mitigate or remediate the RDoC defect. Lack of investment for RDoC defect meaning failure to meet the intent of TD/1 and therefore failure to comply with legislation. Enforcement action from HSE	No
Defect Mitigation (Fencing and Ditchboard Installation)	Smaller CAPEX investment is required for the RDoC defect compared to Topsoil Importation. Quicker than Topsoil importation	Intervention does not change the depth of cover over the pipeline where the defect is identified. Defect may worsen over time, leading to significant consequences discussed in Consequence of Failure.	Yes
Defect resolution (Topsoil importation)	This investment completely removes the RDoC defect.	Higher CAPEX investment than fencing or ditchboard installation. Landowner approval required.	Yes

		Redesigning the landscape.	
Remove and re-lay affected section of the pipeline	This investment mitigates the impact of any third-party strike on the pipeline.	Higher CAPEX investment. Outages required.	No
Diversion	This investment resolves the issue as the asset where RDoC defect is identified is no longer in operation.	Very high technical complexity, multiple assessments such as FEED studies, routing studies etc. would need to take place to select a diversion route. Long duration. Outages required.	No

11.3 Watercourse crossings interventions

Reduced Depth of Cover on Watercourse Crossings Interventions

Counterfactual (Do Nothing)

11.3.1 This intervention involves continuing with existing pipeline DOC inspection and maintenance schedule and monitor asset condition to ensure that the pipelines maintain an adequate depth of cover and that the condition of the banks of the watercourse do not present an integrity threat to the assets, without any remediation.

11.3.2 This is not acceptable as a solution for defects identified as the consequence of not remediating/resolving a RDOC defect would be significant.

Reinstatement of Cover

11.3.3 This intervention follows an optioneering process that involves consulting local environmental stakeholders such as local environmental, geomorphological flood management and fisheries experts, to select the most suitable remediation intervention for the defect out of all possible engineering solutions that may be considered.

11.3.4 The possible engineering solutions naturally vary from site to site, depending on the specific characteristic of the actual crossing. No feeder outage or pressure reduction is required to undertake this intervention.

Replacement of the Pipe

11.3.5 This intervention involves replacing the affected section of the pipeline with a new section of heavy walled pipe. This heavy walled pipe reduces the risk of structural deformation and mitigates the impact of any damage to the pipe. Feeder outage is required.

Diversion

11.3.6 This intervention involves laying a new section of Pipeline along an alternative route to avoid the issues at the current location. Feeder outage is required.

Intervention Summary

11.3.7 Table 15 summarises all investments considered for **Reduced Depth of Cover on Watercourse Crossings**.

Table 15 Interventions considered for Reduced Depth of Cover on Watercourse Crossings

Intervention	Pros	Cons	Taken forward
Counterfactual (Do nothing)	No CAPEX required.	Unacceptable to ignore threat, resulting in lack of compliance with statutory obligations.	No
Reinstatement of Cover	"Do minimum" option to maintain compliance. The lowest whole life intervention to resolve the issue, manage the risk on the NTS and comply with standards and legal requirements.	Complex process involving getting approvals from the Environmental stakeholders on designs, uncertain and challenging.	Yes
Replace	Completely remediates DOC issue.	High cost, resource and duration to replace a pipeline. Requires feeder outage. Does not offer value for consumers.	No

Diversion	Completely remediates DOC issue.	Higher cost, resource and duration to deliver a diversion. Requires feeder outage. Not appropriate for use as a blanket remediation method and should be used in exceptional circumstances. High cost to eliminate risk is not practicable and does not offer consumers value.	No

Redundant Watercourse Crossings Interventions

11.3.8 Four intervention options have been considered to address the problem statement related to **Redundant Watercourse Crossings**.

11.3.9 Risk assessment is conducted when selecting the preferred option for this problem statement. The following is considered in the process:

- Public safety.
- Environmental protection.
- Future land use.
- Legal duties and residual liabilities.
- Practical difficulties and financial considerations.
- Maintenance requirements.

Counterfactual (Do Nothing)

11.3.10 This intervention involves leaving pipeline assets in situ without carrying out any intervention and continuing with mandatory inspection to comply with legislation. We would remain accountable for opex and maintenance on the redundant pipe, ultimately costing the consumer money.

Leaving the pipeline in-situ with grouting

11.3.11 This intervention involves pipeline abandonment grouting is a process of filling decommissioned pipelines with a cementitious grout or slurry. Grout is a low-cost fill material made from cement and pulverised fuel ash, has little inherent strength, but is sufficient to fill a void. This may involve removing components (e.g. valves) and capping open ends so as to leave all sections gas tight and safe.

Leaving the pipeline in-situ with foamed concrete

11.3.12 This intervention involves filling the pipeline with foamed concrete, a type of porous concrete which is light weight and low density, as it comprises approximately 50% air.

11.3.13 This may involve removing components (e.g. valves) and capping open ends so as to leave all sections gas tight and safe

Removal of the pipeline

11.3.14 This intervention involves lifting and removing pipe sections to be abandoned.

Intervention Summary

11.3.15 Table 16, below, summarises all interventions considered for **Redundant Watercourse Crossings**.

Table 16 Interventions considered for redundant watercourse crossings.

Investment	Pros	Cons	Taken forward
1 Counterfactual (Do nothing)	Avoids the one-off cost associated with executing end of life interventions	Continued sustainment of redundant assets incurs ongoing costs relating to inspections and maintenance. As assets degrade over time, this may lead to increased remedial works being required at cost to the consumer. Deferring the inevitable spend would impact future consumers.	No
2 Leaving the pipeline in-situ with grouting	This is a cost-effective solution for securing and stabilizing underground utilities. Prevents water transport, prevents future collapse, and ensures retention of structural strength.	Weaker than foamed concrete.	No

3 Leaving the pipeline in-situ with foamed concrete	It is fluid and so is workable and can be applied through small openings.	Higher material cost.	No
4 Removal of the pipeline	Completely remediates the issue. No further maintenance required.	The abandoned section may obstruct land use and pose a hazard to agricultural machinery, or an abandoned pipeline section left in-situ may hamper future land developments and reduce the value of the land. Higher cost of intervention.	Yes

[redacted] **Inspection interventions.**

11.3.16 Three intervention options have been considered to address the problem statement related to [redacted]

Counterfactual (Do Nothing)

11.3.17 This intervention involves not undertaking any inspection which is not acceptable as the asset condition continues to be unknown and should the asset fail, it could cause a compound effect. Additionally, we would be non-compliant to legislation.

Routine maintenance using an existing Pipe Inspection Vehicle (PIV)

11.3.18 This intervention involves using an existing PIV to inspect the tunnel structure. The existing PIV was designed to enter a circa [redacted] via a 90 deg bend and was slightly positively buoyant to lightly run along the pipe to carry out a CCTV survey and profiling sonar survey to determine silt & debris levels.

11.3.19 No feeder outage or pressure reduction is required to undertake this intervention.

Visual inspection with a Remote Operated Vehicle

11.3.20 This option involves modifying an articulating PIV to access the tunnel via a [redacted] with a 90deg bend at the base which provides direct access into the tunnel.

11.3.21 Due to the diameter of the pipe and the presence of the gas pipe and associated support brackets, we need to create a bespoke vehicle to access the void inside the tunnel whilst working around the pipeline and pipe supports.

11.3.22 No feeder outage or pressure reduction is required to undertake this intervention.

Intervention Summary

11.3.23 Table 17 summarises interventions considered for **River Exe River Crossing Inspection**.

Table 17 Interventions considered for River Exe River Crossing Inspection

Intervention	Positives	Negatives	Taken forward
1 Counterfactual (Do nothing)	No CAPEX spend.	This is not an acceptable option as the asset condition continues to be unknown and should the asset fail, it could cause a compound effect. Non-compliant to legislations	No
2 Routine maintenance using an existing Pipe Inspection Vehicle (PIV)	Uses existing equipment. Lower cost. Readily available resource.	Unsuitable due to dimensions and design of the structure.	No
3 Visual inspection with an ROV	Uses customised equipment to inspect.	Higher cost. May take longer to manufacture the ROV.	Yes

11.4 Nitrogen sleeves interventions

Interventions

11.4.1 We have considered several inspections and interventions for Nitrogen sleeves.

11.4.2 If following an inspection, issues are identified then analysis is undertaken and the lowest whole life cost intervention that meets the technical requirements and legal obligations is implemented.

Counterfactual (Do Nothing)

11.4.3 This intervention involves carrying out annual maintenance to check that the nitrogen pressure remains between 0.6 bar and 1.0 bar. Pressure loss between inspections is an indication that nitrogen is leaking from the sleeve to atmosphere and the inert atmosphere will not be preserved.

Nitrogen Sleeve Remediation- Minor

11.4.4 This intervention involves refurbishment of leaking sleeves which can include the following:

- **Replacement of failed components (including hoses, valves, Nitrogen fill points etc.)**: This applies to all types of seal where the cause of the leak is attributed to the riser pipe, valve, flange, hose connection or hose to the fill and test point.
- **Replacement of flexible end seals:** This requires significant excavation and an outage of the pipeline and is only carried out when the leak has been directly attributed to the flexible end seal.
- **Replacement of flexible end seals and top up of Nitrogen:** After replacing end seals on flexible end seals sleeves, top up of Nitrogen.

Nitrogen Sleeve- Grouting

11.4.5 This intervention involves removing the nitrogen within the sleeve and replace this with an inert grout that has corrosion inhibitors within it.

Intervention Summary

11.4.6 Table 18 summarises the interventions considered for Nitrogen Sleeves.

Table 18 Interventions considered for Nitrogen Sleeves

Investment	Positive	Negative	Taken forward
1 Counterfactual (Do Nothing)	There is no CAPEX investment required for Nitrogen Sleeve.	Intervention does not mitigate or remediate the leaking Nitrogen Sleeve. Lack of investment for Nitrogen Sleeves has several significant consequences.	No
2 Nitrogen Sleeve Remediation- Minor	Temporarily remediates the leak, Sleeve deteriorates over time, may start leaking again.	Excavation of sleeve at the fill point location required. Outage of the pipeline may be required if flexible end seals are being replaced.	Yes
3 Nitrogen Sleeve Grouting	A permanent repair with no further maintenance required. Preferred, where appropriate, to avoid more costly alternative cut out and replacement interventions	More difficult technically compared to minor remediation. A specialist activity thus challenging to find a supplier to carry out this intervention.	Yes

11.5 Marker post interventions

11.5.1 Due to the nature of the asset, there is no alternative to resolving the issue presented in the Problem Statement above other than replacing/installing a Marker Post.

Counterfactual (Do Nothing)

11.5.2 This intervention involves carrying on with the current maintenance/monitoring regime.

Replace faulty Marker Post/ Install new Marker Post

11.5.3 This intervention involves replacing existing faulty/ damaged Marker Posts and installing new Marker Post where it is not currently present. This could be due to diversion, changes in landscape (i.e., crossings points), field boundaries etc. No feeder outage or pressure reduction is required to undertake this intervention.

Intervention Summary

11.5.4 We have assessed the Pros and Cons of the intervention options and summarised in Table 19.

Table 19 Interventions considered for Marker Posts

Intervention	Positive	Negative	Taken forward
1 Counterfactual (Do Nothing)	There is no CAPEX investment required for Marker Post	If the asset continues to deteriorate to an extent where it is not visible to the public or if the location of the Pipeline is not made clear due to absence of a Marker Post, we fail to comply to legislation	No
2 Replace faulty Marker Post/ Install new Marker Post	This investment remediates faults/damages identified on Marker Post. This also enhances our asset health knowledge of this asset base. Compliant to PSR.	CAPEX required.	Yes

11.6 Slabbing interventions

Interventions

11.6.1 We have considered several interventions to resolve the infringement issue presented in the problem statement chapter, including:

Counterfactual (Do nothing)

11.6.2 This intervention does not involve any CAPEX investment to protect our pipeline asset in areas of infringement and means we accept high levels of risk to the public from our network. IGEM/TD/1 edition 6 leaves the decision of when and where to act to the pipeline operator to reduce third party risks.

11.6.3 Having reviewed outputs of the cost benefit analysis performed for these locations, we have deemed that action must be taken at these locations to reduce the risk to comply with our obligations under PSR 1996 therefore this investment has been discounted.

Diversion

11.6.4 This investment involves moving the pipeline further away from the local population and/or relaying the pipeline in heavy wall pipe that has a lower failure frequency.

11.6.5 This would be an effective means of reducing the risk at these locations and may provide a greater absolute risk reduction than slabbing. However, the costs are significantly higher and therefore diversion does not present a good value option, and it has been discounted.

Decommissioning the pipeline

11.6.6 This intervention involves decommissioning the feeder section from our network.

11.6.7 Network modelling shows that the four pipelines presented in this paper are all needed to achieve the required flows on our network to meet our supply and demand. Therefore, decommissioning the pipelines is not possible for these locations. Feeder outage and/or pressure reduction is required to undertake this intervention.

Reducing pressure on the pipeline

11.6.8 This intervention involves reducing the pressure of gas flow through the feeder.

11.6.9 Limiting the pressure at these locations is not possible without capital investment in pressure control devices which would be of a similar or greater cost than installing slabbing to protect the pipeline and those devices would require maintenance, so more costly in long-term. In addition, this would impact on our ability to operate the NTS. Pressure reduction is required to undertake this intervention.

Slabbing

11.6.10 This intervention involves installing slabs above the pipeline and typically buried more than 1m below the surface. This reduces the frequency of damage to the pipeline by protecting from third party excavations and other activity. There are three styles of slabbing including concrete slabbing, polymer slabbing and polymer high visibility mesh.

11.6.11 After evaluating the pros and cons of each high-level investment intervention listed above, we have shortlisted slabbing due to it reducing the risk to the pipeline and adjacent population for the lowest cost whilst retaining the ability to use the pipeline.

11.6.12 In the four locations where infringement is present, and we must intervene to reduce the risk to ALARP level under obligation. We intend to use the four locations listed in this paper to trial the three slabbing technologies. This will provide experience and information on the installation methods of each option.

11.6.13 Three slabbing alternatives with varying lengths have been considered at each location. Further details of these are provided here:

Length for minimum Cost Per Casualty Avoided (CPCA)

11.6.14 This is length of protection that produces the minimum cost per casualty avoided, IE the greatest risk reduction for the least cost. This is automatically calculated using the Pipesafe software and does not account for details of the specific location such a roads and property boundaries.

Engineering Judgment

11.6.15 This length has been suggested by the risk consultants [redacted]. This is a higher cost intervention than the minimum CPCA but accounts for site specific features or constraints. This option provides adequate protection to properties affected by the infringement and following completion would result in compliance with industry standards. This option assumes limited further growth of developments.

Removing the infringement

11.6.16 This length of protection completely removes the TD/1 infringement by fully protecting the pipeline that may impact the assessed population. This would bring the location back into full compliance with TD/1 and would allow for continued development.

Intervention Summary

11.6.17 Table 20 summarises interventions considered for **slabbing**.

Table 20 Interventions considered for Slabbing.

Slabbing option	Pros	Cons	Taken forward
Length for minimum CPCA	This length provides the best risk reduction value against spend.	Does not acknowledge specific features of a location such as land ownership boundaries or road crossings of the pipeline. It may leave section of pipeline unprotected that it would be reasonable to expect National Gas to protect. Does not provide any allowances for future creeping development.	No
Engineering Judgment	This provides additional protection that will reduce the risk further for populations today and allow for some creeping development at a location.	There is an additional cost beyond the length for minimum CPCA.	Yes
Removing the infringement	This will remove the infringement completely and bring the risk levels as low as possible without modifying the pipeline.	The costs for this length are significantly higher than the other two options. This length will also protect sections of pipeline where the risk is not meaningfully higher than the standard risk expected for a pipeline under TD/1 and TD/2.	No

Volume derivation

11.6.18 Table 21 below provides a summary of the approach for volume derivation for the interventions taken forward from our option assessment.

Table 21 Bottom up RIIO-GT3 intervention volumes.

Intervention	Volume	Unit of Measure	How this volume has been developed
Defect Mitigation (Fencing and Ditchboard Installation)	91	Per project	• the number and type of defects currently identified. • the number of defects forecast to arise during the investment period, the basis for this being the historic rate found over the last 10 years. • the historic run rate of remediation
Defect resolution (Topsoil importation)	1	Per project	
Watercourse crossings defect resolution	32	Per project	• the number and type of defects currently identified. • the number of defects forecast to arise during the investment period, the basis for this being the historic rate found over the last 10 years. • the historic run rate of remediation
Deerhurst Feeder 2 contaminated river crossing	1	Per project	Bespoke needs case
Bridstow Contaminated River crossing	1	Per project	
Worthenbury Dee duplicate river crossing decommissioning	1	Per project	
Visual inspection with an ROV (River Exe- ROV Survey)	1	Per project	
Nitrogen sleeve remediation - Minor	350	Per asset	Volumes derived from existing defect data.
Nitrogen Sleeve- Grouting	105	Per asset	
Replace faulty Marker Post/ Install new Marker Post	9,998	Per asset	Based on results from inspections carried out in RIIO-T2 and delivery rate

IGEM/TD/1 infringement remediation	4	Per project	The four locations listed below have been reviewed using the HAMM methodology and it has been found that mitigation measures are required: • The locations have been highlighted during the 4 yearly aerial survey of the respective pipeline. • The locations have been through a coarse risk assessment to determine if a detailed assessment is required. All these locations were determined to require a detailed assessment. • A detailed assessment was conducted for each location that determined the risks were greater than those permitted under TD/1. Therefore, they were all put forward for cost benefit analysis. For each of the locations a CBA has been conducted. At all four locations the CBA has shown that slabbing would provide sufficient risk reduction compared to the installation costs. This process is described further in appendix 11.

Unit Cost Derivation

11.6.19 Our unit costs for the above interventions have been based on historical outturn cost of 38 data points across two RDoC mitigation investments and an estimate based on a project of Topsoil importation investment. A summary is provided in Table 22 with cost breakdowns provided in Appendix 9 – Cost Breakdown.

Table 22 RDoC Intervention Unit Cost Summary Table (£, 2023/24)

Intervention	Unit of Measure	Unit Cost	Cost Accuracy	Number of Data Points	Source Data
Defect Mitigation (Fencing and Ditchboard Installation)	Per project	[redacted]	+/-10%	38	Historical outturn
Defect resolution (Topsoil importation)	Per project	[redacted]	+/-10%	0	Estimate derived by first principles.
Watercourse crossings defect resolution	Per project	[redacted]	+/-10%	22	Historical outturn
Deerhurst Feeder 2 contaminated river crossing	Per project	[redacted]	+/-30%	0	Estimate based on third party tendered documents and drawings
Bridstow Contaminated River crossing	Per project	[redacted]	+/-30%	0	
Worthenbury Dee duplicate river crossing decommissioning	Per project	[redacted]	+/-10%	0	
Visual inspection with an ROV (River Exe- ROV Survey)	Per project	[redacted]	+/-30%	0	Estimate at Cost of Completion
Nitrogen sleeve remediation - Minor	Per project	[redacted]	+/-10%	20	Historical outturn
Nitrogen Sleeve- Grouting	Per project	[redacted]	+/-10%	30	
Marker Post Replacement	Per asset	[redacted]	+/-10%	380	Historical outturn
TD/1/ Slabbing Feeder 15 Bretherton to Warburton (Taylors Farm Shop)	Per project	[redacted]	+/-10%	0	Estimate derived by first principles.
TD/1/ Slabbing Feeder 6 Pickering to Burton Agnes	Per project	[redacted]	+/-10%	0	
TD/1/ Slabbing Churchover to Wormington	Per project	[redacted]	+/-10%	0	
TD/1/ Slabbing Feeder 15 Bretherton to Warburton (Culcheth High School)	Per project	[redacted]	+/-10%	0	

Cost example

11.6.20 Unit cost of Topsoil Importation was based on a project located at Wittering, in which 10,000 tonnes of topsoil was used to restore pipeline cover by reprofiling a 300m length of land. This is considered representative of the length we would likely encounter in future.

11.6.21 The cost for marker post replacement intervention has been developed using historic outturn data for 380 marker post replacements undertaken across three regions. As part of cost development, we have broken down the costs into labour and materials. The examples included additional costs to cover public highway traffic management requirements and the potential for replacements taking slightly longer to complete due to hard to reach pipeline easements. These have been factored into the final average unit cost calculations.

12 Options Considered

12.1 Portfolio Approach

12.1.1 In developing our plans, we focused on value for money and deliverability, while managing the risks of aging assets. We evaluated the cost-effectiveness of our investment program through a full Cost Benefit Analysis (CBA) using the NARMs Methodology within the Copperleaf Decision support tool.

12.1.2 In Line with HM Treasury Green Book advice and Ofgem guidance, we assessed the value of investing in Pipeline Protection across the RIIO-GT3 period by analysing the cost benefit over a 20-year horizon.

12.1.3 We derived intervention volumes using the engineering assessments described in the previous chapters. Each investment was assessed via the Ofgem-approved NARMs Methodology embedded in Copperleaf, quantifying risk reduction and Long Term Risk Benefit (LTRB). Analysing this performance, Copperleaf Predictive Analytics is then able to select further NARM driven interventions to create further options to satisfy certain criteria, such as stable risk across the portfolio.

12.1.4 Only interventions assigned to a specific asset have been assessed in the CBA, as benefits cannot be applied to interventions across various locations (e.g., based on forecast defects). This is because the land above or surrounding the pipeline are not recorded as assets within our core systems. Therefore, RDOC Defect Mitigation- Fencing and Ditch Board Installation, RDOC Defect Resolution- Topsoil Importation, Nitrogen Sleeve Remediation – Minor, Nitrogen Sleeve- Grouting and Marker Post Replacement could not be modelled or included in the option costs.

12.1.5 Surveys such as [redacted] have also not been modelled. [redacted] have also not been modelled as the assets are proposed to be decommissioned, therefore no benefits would be realised.

12.1.6 Sections of pipelines where watercourse crossings investments proposed were first analysed in the model which considered defect rate and rate of external interference and its consequences and generated the outcome value. We then compared it against a baseline value based on the current depth of cover. We also modelled the various stabbing options mentioned in Chapter 11 to assess the most cost-beneficial programme option.

12.2 Options

12.2.1 All the options described below have been assessed against our Option 0, Counterfactual (Do Nothing) option, which considers no investment over and above maintenance and corrective repairs.

12.2.2 In all options (except the counterfactual) we include investment volumes that have been developed through our bottom-up intervention development, to address know defects issues. The options are summarised in Table 19.

Option 1: Bottom up portfolio of works.

12.2.3 In this option we modelled the work list identified in this EJP to manage third party risk to pipeline assets. This worklist is unconstrained by delivery constraints and reflects bottom up development of the worklist.

Option 1A: Post deliverability assessment of Bottom up portfolio of works.

12.2.4 In this option we modelled the work list identified in this EJP to manage third party risk to pipeline assets which consists of the spend listed in table 3. This is the above option 1 but includes changes made following a deliverability assessment of the worklist proposed.

Option 2: Minimum CPCA Slabbing & Watercourse Crossing

12.2.5 As option 1a above but varies the TD/1 remediation option to include the minimum CPCA slabbing option at the four locations identified with societal risk higher than ALARP.

Option 3: Engineering Justification Slabbing and Watercourse Crossing

12.2.6 As option 1a above but varies the TD/1 remediation options and includes the engineering justification slabbing option at the four locations identified with societal risk higher than ALARP.

Option 4: Remove Infringement Slabbing and Watercourse Crossing

12.2.7 As option 1a above but varies the TD/1 remediation options and includes the remove infringement slabbing option at the four locations identified with societal risk higher than ALARP.

12.3 Slabbing CBA

12.3.1 Individual CBAs on slabbing options at each location has also been undertaken and incorporated into the above options. The results of the CBA are compared to the criterion in Table 23.This table includes the value of preventing a fatality, published by the Department for Transport, adjusted for inflation. Below this are the three criterion levels set by National Gas to determine when risk reduction measures are required. These include a gross disproportion factor, 10, 20, and 30 respectively. This is used to reflect societies aversion to single high fatality events.

12.3.2 The costs shown in the table below, Table 242, have been produced internally by National Gas, they include a fixed setup cost and a cost per metre of concrete slabbing installed. These costs have been used in the analysis to compare between slabbing options for each location. The results of these are provided in the Appendix 8.

Table 23 Slabbing costs and CPCA criterions.

Parameter	Value
Fixed setup cost (£)	[redacted]
Variable cost (£/m)	[redacted]
Value of preventing a fatality (£M)	[redacted]
CPCA criterion for 10 to 100 max causalities (£M)	[redacted]
CPCA criterion for 101 to 1000 max causalities (£M)	[redacted]
CPCA criterion for over 1000 max causalities (£M)	[redacted]

12.4 Option Summary

12.4.1 Table 24 presents the technical summary table.

Table 24 Options Technical Summary Table (£m, 2023/24)

Option	First Year of Spend	Final Year of Spend	Total Volume of Interventions	Investment Design Life	Total Spend Request
Option 1: Pre deliverability	FY27	FY31	10,585	40 years	[redacted]
Option 1A: Post deliverability	FY27	FY31	10,585	40 years	[redacted]
Option 2: Minimum CPCA Slabbing & Watercourse Crossing	FY27	FY31	10,585	40 years	[redacted]
Option 3: Engineering Justification Slabbing & Watercourse Crossing	FY27	FY31	10,585	40 years	[redacted]
Option 4: Remove Infringement Slabbing & Watercourse Crossing	FY27	FY31	10,585	40 years	[redacted]

13 Business Case Outline and Discussion

13.1 Key Business Case Drivers Description

13.1.1 In developing our risk forecasts and proposed plans we have considered the impact of the following drivers for investments in Pipeline Protection:

- Legislation covering requirements to maintain safe assets and adequately protect them.
- Safety to general population.
- Asset deterioration

13.2 Business Case Summary

13.2.1 NGT has a duty to comply with Regulations 6, 13 and 16 of PSR 1996.

13.2.2 By undertaking the proposed interventions in this EJP, we have presented the lowest-cost option to mitigate the reliability, safety, and environmental risks for our Pipeline assets.

13.2.3 A variety of technical interventions have been considered and combined to create a range of CBA options, the results of which are presented in Chapter 12.

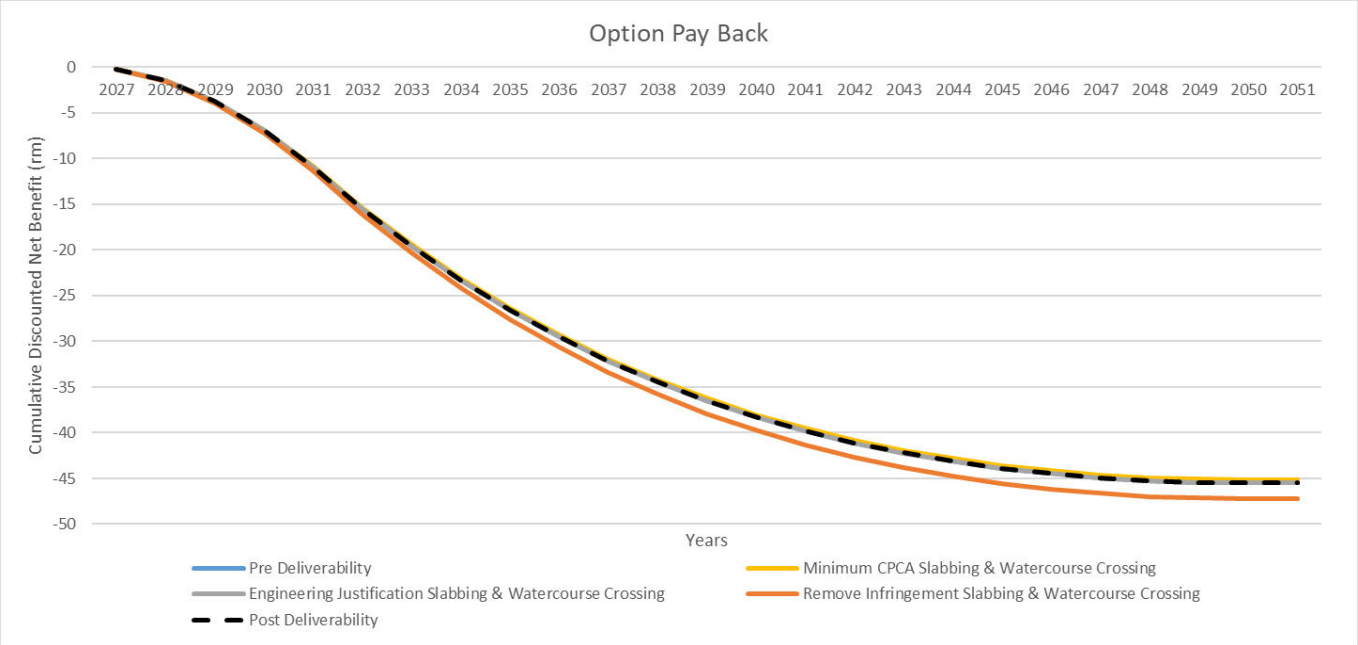


Figure 13 Payback graph of Pipeline Protection programme options

Table 25 Option summary of headline business case metrics (£m, 2023/24)

Option	Total Volume of Interventions	Total Spend Request (£m, 2023/24)	Outcome Risk End of RIIO-GT3	% change in comparison to start of RIIO-T2	NPV (£m, 2023/24)	Payback Period from 2031	% change in service risk measures compared to start of RIIO–T2				
							Financial	Health and safety	Environmental	Availability Reliability	Societal
Option 1: Pre Deliverability	10,549	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Option 1A: Post Deliverability	10,585	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Option 2: Minimum CPCA Slabbing & Watercourse Crossing	10,585	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Option 3: Engineering Justification Slabbing & Watercourse Crossing	10,585	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Option 4: Remove Infringement Slabbing & Watercourse Crossing	10,585	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

13.2.4 Results in the CBA show that the programme of work proposed does not pay back in the period specified by Ofgem. However, the consequences of lack of investment to address the problem statements experienced with watercourse crossings and societal risks above ALARP result in a requirement to carry out the worklist proposed in this EJP.

14 Preferred Option Scope and Project Plan

14.1 Preferred Investments and Project Plan

14.1.1 The preferred option to manage our pipeline protection assets is Engineering Justification Slabbing and Watercourse Crossing which is listed as Option 1A. Whilst this isn't the cheapest option, it protects our NTS from future development infringing upon our pipelines. Our programme of investment on pipeline protection assets has been taken through a deliverability assessment which assesses this programme of works against outputs across our entire capital investment plan. This results in a slightly adjusted option 1A which includes the mixture of interventions listed in Table 26.

14.1.2 Our proposed investment maintains statutory compliance and risk management of our existing assets required for future need whilst striking an appropriate balance between tolerable risk and value for money for consumers on our redundant assets.

Table 26 Preferred option summary (£m, 2023/24)

Intervention	Primary Driver	Volume	Unit of Measure	% Assets Intervened Upon	Total RIIO-GT3 Request	Funding Mechanism	PCD Measure
RDOC Defect Mitigation- Fencing and Ditch Board Installation	AH Risk Management	91	Per project	[redacted]	[redacted]	[redacted]	NARMS
RDOC Defect resolution- Topsoil Importation	AH Risk Management	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
Watercourse crossings defect resolution	AH Known Defects Primary	32	Per project	[redacted]	[redacted]	[redacted]	NARMS
Deerhurst Feeder 2 contaminated river crossing	Redundant Assets	1	Per project	[redacted]	[redacted]	[redacted]	Redundant Assets PCD
Birdstow Contaminated River crossing	Redundant Assets	1	Per project	[redacted]	[redacted]	[redacted]	Redundant Assets PCD
River Exe- ROV Survey	AH Policy	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
Worthenbury Dee duplicate river crossing decommissioning	Redundant Assets	1	Per project	[redacted]	[redacted]	[redacted]	Redundant Assets PCD
Nitrogen sleeve remediation - Minor	AH Known Defects Primary	350	Per asset	[redacted]	[redacted]	[redacted]	NARMS
Nitrogen Sleeve- Grouting	AH Known Defects Primary	105	Per asset	[redacted]	[redacted]	[redacted]	NARMS
Marker Post Replacement	AH Legislation	9,998	Per asset	[redacted]	[redacted]	[redacted]	NARMS
TD/1/ Slabbing Feeder 15 Bretherton to Warburton (Taylors Farm Shop)	AH Legislation	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
TD/1/ Slabbing Feeder 6 Pickering to Burton Agnes	AH Legislation	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
TD/1/ Slabbing Churchover to Wormington	AH Legislation	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
TD/1/ Slabbing Feeder 15 Bretherton to Warburton (Culcheth High School)	AH Legislation	1	Per project	[redacted]	[redacted]	[redacted]	NARMS
Total		**10,585**	[redacted]	[redacted]	[redacted]	-	-

14.1.3 Due to rounding to 1 decimal place for the funding request column the total value does not exactly equal the spend requested in this EJP.

14.1.4 Our costs and volumes have been built using a formalised methodology using outturn data for similar works and bottom-up estimates for new interventions therefore we propose the worklist within this EJP is funded via baseline and will be assessed using NARMs methodology.

[redacted]

14.3 Investment Risk Discussion

14.3.1 The overall investment risk in this EJP is considered low. The drivers of this investment are legislation and to comply with the assurances we provided to the HSE following the received HSE Action Legal, we need to ensure this worklist is funded and delivered successfully.

14.3.2 The scope of this worklist is well defined and understood. The programme of this work is well established, and we have good track record of delivering these scopes in RIIO-T2.

14.3.3 Most of the worklist in this EJP will require a pressure reduction to deliver with decommissioning activities requiring an outage. This worklist has been assessed via a deliverability assessment as deliverable in accordance with the spend profile. The delivery process of Watercourse crossings defect resolutions involves obtaining consent from the Environmental stakeholders on designs, which can impact upon timescales. Therefore, there is a risk associated with the delivery timescales for this intervention.

14.3.4 Our costs have been built through unit cost analysis and estimates from the market, however there is a risk that costs of materials may increase due to macro-economic conditions and customer and stakeholder demand. This shall partly be mitigated through the CPI-H inflation and real price effect mechanisms within our RIIO-GT3 regulatory framework.

14.4 Project Plan

14.4.1 Project delivery has been split into three phases which align with our Network Development Process (ND500) as follows. Commissioning dates are not relevant to all intervention types but take place at the end of the delivery phase.

Table 27 Delivery phase alignment with ND500

Delivery Phase	ND500 Stage Gate(s)
Preparation	T0, T1, F1 (Scope establishment), T2, F2 (Option selection), T3, F3 (Conceptual Design Development and Long Lead Items Purchase), T4
Delivery	F4 (Execute Project), T5, Available for Commercial Load (ACL), T6
Close Out	F5 (Reconcile and Close)

14.4.2 The below table shows the summary plan and provisional delivery phases for pipeline protection investments within RIIO-GT3. Internal stakeholder engagement has identified when we can obtain network access, where required, to complete these works.

Table 28 Pipeline Protection Portfolio Programme for RIIO-GT3 period

Sanction/Intervention	RIIO-T2		RIIO-GT3					
	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32
T3_Pipelines_FY27								
T3_Pipelines_FY28								
T3_Pipelines_FY29								
T3_Pipelines_FY30								
T3_Pipelines_FY31								
T3_TD1 Resolutions								

14.4.3 The work has been profiled based on a deliverability assessment across the whole NGT plan and can be delivered alongside the portfolio of work submitted for RIIO-GT3.

14.5 Key Business Risks and Opportunities

14.5.1 Any changes to system operation or supply and demand scenarios will not impact upon the outcome of this justification paper.

14.5.2 However, a transition to Hydrogen within the UK gas network may affect the investments proposed in this EJP. If a decision is taken to repurpose existing pipelines, number of watercourse crossings decommissioning projects and marker post replacement may change. A reduction in the number of pipelines available to transport methane will make facilitating future pipeline outages for maintenance activities increasingly difficult.

14.6 Outputs included in RIIO-GT2 Plans

14.6.1 This RIIO-GT3 investment plan does not contain any re-inclusion of previously funded/proposed investments in RIIO-T2.

15 Appendices

15.1 Appendix 1 Legislations

15.1.1 We are obliged to comply with legislation and standards, under the Pipelines Safety Regulations (PSR), 1996, specifically regulation 13, which states: "The operator shall ensure that a pipeline is maintained in an efficient state, in efficient working order and in good repair." In certain circumstances where and event does not achieve the standard, it may be appropriate to assess it to understand whether the event is still as low as reasonably practicable (ALARP) level,

15.1.2 Additionally, PSR '96 Regulations 16 is relevant for marker posts, which states: "For the purpose of ensuring that no damage is caused to a pipeline, the operator shall take such steps to inform persons of its existence and whereabouts as are reasonable".

15.2 Appendix 2 - More info on RDOC Equipment Summary

15.2.1 The depth of ground cover above the pipeline is essential for managing the risk of damage to the pipeline by third parties and thereby enabling our compliance with PSR 1996 Regulation 9, which states that:

"The operator shall ensure that no fluid is conveyed in a pipeline (safe for the purpose of testing it) unless it has been so constructed and installed that, so far as is reasonably practicable, it is sound and fit for the purpose for which it has been designed."

15.2.2 Table 29 below summarises the minimum depth of cover requirements for pipelines specified in IGEM/TD/1, based on location and date of construction:

Table 29 Summary of DOC Requirements in IGEM/TD/1

Location	Requirements for pipelines constructed up to and during 1984 (metres)	Requirements for pipelines constructed during or after 1985 (metres)
Rural and Suburban Areas	0.9 (later increased to 1.1m in Edition 2 (1984))	1.1
Roads	There were no specific cover requirements for road, rail, and watercourse crossings prior to Edition 5 of IGEM/TD/1 other than a requirement in Edition 2 and later editions for greater than 300 mm above the concrete slab that was required when crossing under a ditch.	1.2
Water courses, canals and rivers		1.2
Railways		1.4

15.2.3 The key asset management challenges are:

- Usage based erosion (Land use e.g., ploughing, excavation etc)
- Natural erosion (e.g., wind, flooding etc), which present an increased risk of third-party damage to the Pipeline. This in turn presents a risk to pipeline structural integrity and the associated safety and environmental implications.

15.3 Appendix 3 - More info on Watercourse crossing equipment summary.

15.3.1 The definitions of these terminology set out by UKOPA in the document - *Good Practise Guide for Pipeline Decommissioning and Abandonment dated July 2023* as follow:

Abandoned / Abandonment

- Assets in the abandoned state cannot be put back into service under any circumstances. The pipeline operator has no ongoing legal rights or interests in any off-site assets in this category, other than statutory obligations under the "polluter pays" principle. Decommissioning is a necessary precursor to abandonment.
- Abandonment is synonymous with "permanent decommissioning" (as used in IGEM standards).

Decommissioned / Decommissioning

- Decommissioning refers to the act of removing a pipeline from service. It would typically involve de-pressurising and emptying the contents from the pipeline, isolating the pipeline from process fluids, and de-energising some (but not necessarily all) of the associated equipment. Following decommissioning, a pipeline may be moved to either “mothballed” or “abandoned” status.

Mothballed

- Mothballed assets are assets which have been removed from active service (i.e. have undergone decommissioning), but which could be brought back into service if required. The term may be used synonymously with “decommissioned”, or “in reserve”.

15.4 Appendix 4 - Further info on equipment summary of Nitrogen Sleeves

15.4.1 There are 3 classes of pipeline protection sleeves:

- Class 1, Nitrogen gas filled - primarily installed in areas of high consequence to protect the public or where remediation of corrosion defects would be difficult and expensive. They also protect the pipe from external interference.
- Class 2, Concrete sleeves around and/or concrete slabs above the pipeline - solely for the protection of pipeline from external interference.
- Class 3 – those that facilitate construction of the pipeline.

15.5 Appendix 5 - Further info on equipment summary of Marker Posts

15.5.1 The three types of Marker Posts in the NTS, their functions and locations are summarised in Table 20.

Table 30 Types of Marker Posts in the NTS

Type of post	Description	Location(s)
Aerial Marker Posts (AMP)	A 118mm diameter white plastic post which stand 2m above ground level with a label which identifies the presence of a high pressure pipeline and provides contact telephone numbers.	Located at suitable intervals along the pipeline route with a maximum spacing of 1 km. Also placed either side of river crossings and as near as practicable to any change in direction of the pipeline route or at the nearest boundary crossing.
Boundary Marker (M4) Posts	Originally manufactured using concrete and stand approximately 0.5m above ground. They are now generally manufactured from high density polyethylene. They have a faceplate which identifies the presence of the pipeline and provides contact telephone numbers.	Installed at every boundary where there are no aerial or cathodic protection (M28) posts present.
Cathodic Protection (M28) Posts	Similar design to the M4 Posts, M28 Posts have a hollow section to enable cables attached to the pipeline cathodic protection (CP) system to be brought into the posts for monitoring the level of CP.	Situated at easily accessible locations.

Relevant legislations and standard to Marker Posts asset management

15.5.2 According to IGEM/TD/1, *"the position of the pipeline shall be indicated at suitable intervals by means of marker posts (MP) and/or aerial marker posts (AMP). These should be at all field boundaries so as to be seen in the line of sight, at all crossings and, where practicable, at changes in direction. They shall indicate the location of the pipeline after reinstatement of the ground."*

15.5.3 PSR '96 Regulations 16 states: "For the purpose of ensuring that no damage is caused to a pipeline, the operator shall take such steps to inform persons of its existence and whereabouts as are reasonable".

15.5.4 Our policies (TR/28) define where posts need to be positioned (e.g. road and river crossings, change in pipeline direction etc), however not all the posts are not recorded as individual assets in central data repository Maximo.

15.5.5 In line with the defect management process T/PM/DEFECT/1, when a post is damaged or missing, it is prioritised for repair or replacement based on the following categories:

Table 31 Priority categories of damaged/missing Marker Posts

Priority	Description	Score	Guidance on remediation
High	Post no longer meeting the purpose, i.e. missing or very damaged	15	within 1 month
Medium	Post meeting the purpose though has a defect i.e. faded sign	8	Within 6 months
Low	Overgrown vegetation causing an issue	4-6	Within 12 months

15.6 Appendix 6 [redacted]

[redacted]

15.7 Appendix 7 – [redacted]

[redacted]

15.8 Appendix 8 - Individual CBA of TD/1 Slabbing projects

Location 1: [redacted].

15.8.1 Note: [redacted] and is the pipeline that risk reduction measures should be applied to. Figure 17 shows the FN curve for this location, including the risks from [redacted] The risks extend beyond the risk criterion as defined in TD/2 and this confirmed a CBA was required.

[redacted]

Table 32 [redacted]

Parameter	Risk Reduction Option – Concrete Slabbing		
	Length for minimum CPCA	Engineering Judgment	Removing the Infringement
Location of protection	Unprotected Section closest to small town	Unprotected section	Full interaction Length
Length of protection (m)	[redacted]	[redacted]	[redacted]
Total cost (£)	[redacted]	[redacted]	[redacted]
EV before risk reduction (per year)	[redacted]	[redacted]	[redacted]
EV After risk reduction (per year)	[redacted]	[redacted]	[redacted]
Cost Per Casualty Averted (£Million)	[redacted]	[redacted]	[redacted]

15.8.2 Of the different lengths described above, it is the view of National Gas that the engineering judgement option, 143m is the preference for this location. This extends the slabbing south to reach a local AGI boundary fence and north until benefit per metre decreases such that the benefit is no longer proportionate to the costs of installation. The minimum CPCA does not install slabbing up to AGI boundary so would leave a section of pipeline unprotected where the risk is at a high level, this is reflected in the EV difference. The length to remove the entire infringement is not feasible in this location due to the long length, and the costs are disproportionate to the benefits.

Location 2: [redacted]

15.8.3 Figure 18 shows the FN curve for this location. The risks extend beyond the risk criterion as defined in TD/2 and this confirmed a CBA was required.

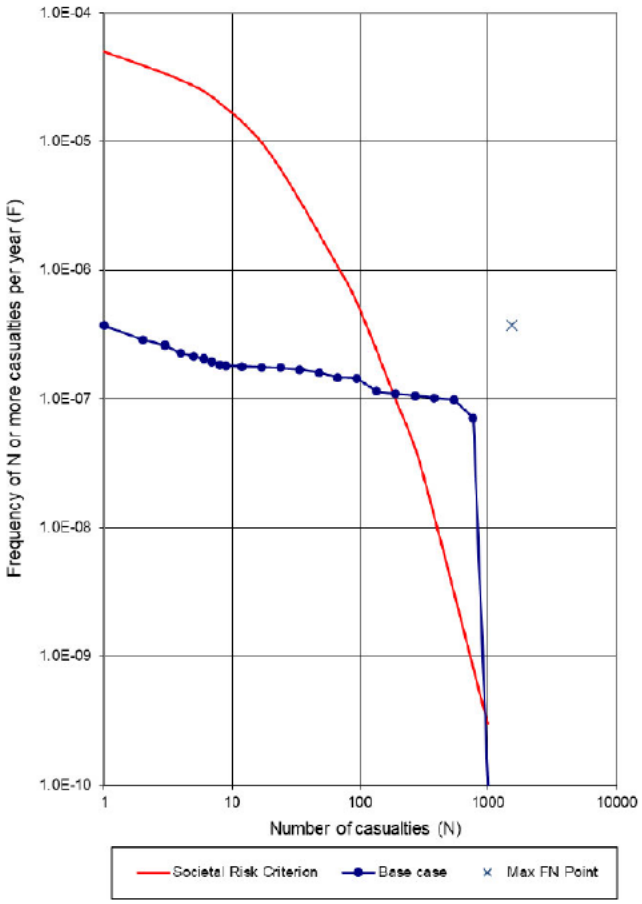


Figure 16 FN curve for [redacted]

Table 33 CBA [redacted]

Parameter	Risk Reduction Option – Concrete Slabbing		
	Length for minimum CPCA	Engineering Judgment	Removing the Infringement
Location of protection	[redacted]	[redacted]	[redacted]
Length of protection (m)	[redacted]	[redacted]	[redacted]
Total cost (£)	[redacted]	[redacted]	[redacted]
EV before risk reduction (per year)	[redacted]	[redacted]	[redacted]
EV After risk reduction (per year)	[redacted]	[redacted]	[redacted]
Cost Per Casualty Averted (£Million)	[redacted]	[redacted]	[redacted]

15.8.4 As shown in the table above, only one length of slabbing was considered for this location. This is because the population here is already protected by heavy wall pipe. The slabbing will be installed for a short run to the north of the heavy wall pipe where the population has increased. This will extend the length of protected pipeline and remove the infringement.

Location 3: [redacted]

15.8.5 Figure 19 shows the FN curve for this location. The risks extend beyond the risk criterion as defined in TD/2 and this confirmed a CBA was required.

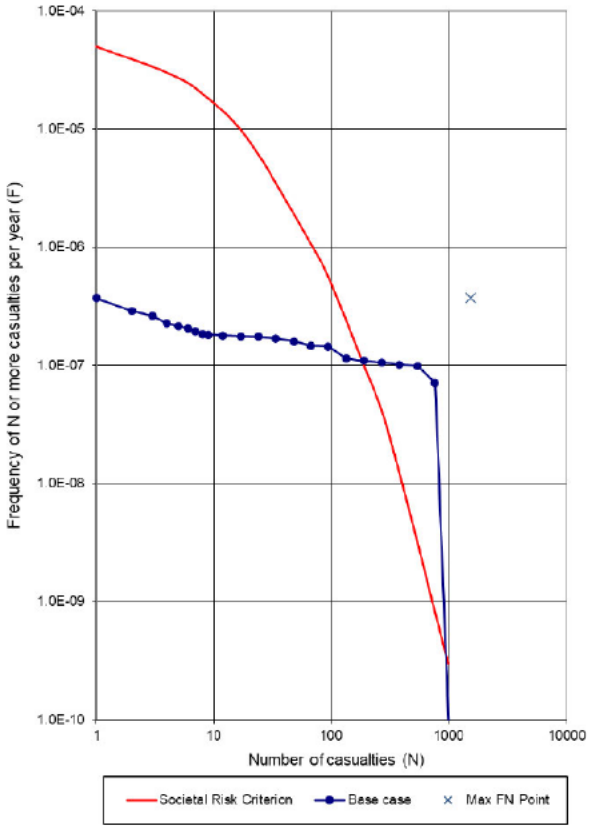


Figure 17 [redacted]

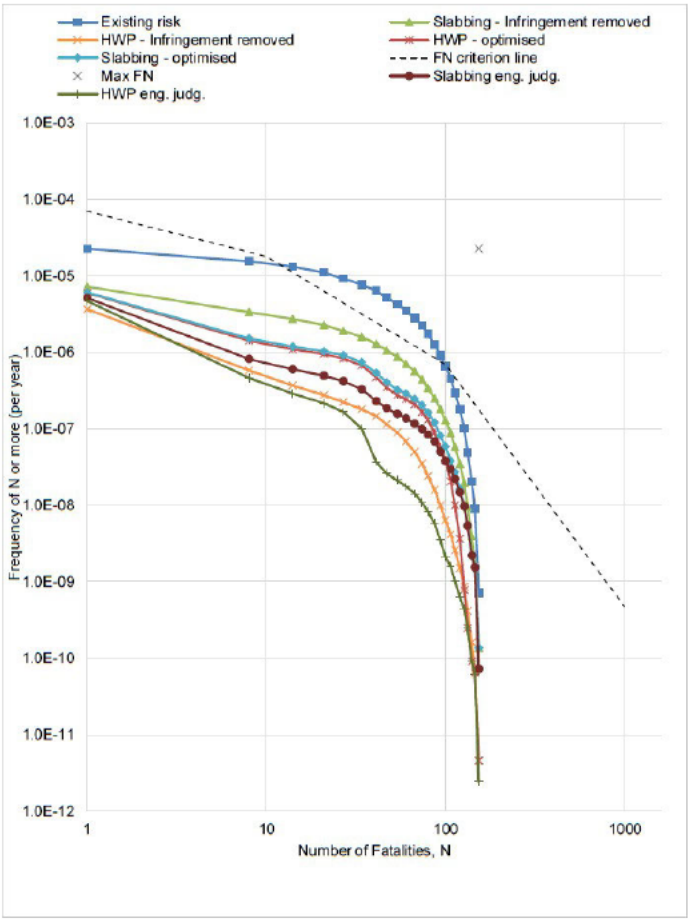
Table 34 CBA results for [redacted]

Parameter	Risk Reduction Option – Concrete Slabbing		
	Length for minimum CPCA	Engineering Judgment	Removing the Infringement
Location of protection	[redacted]	[redacted]	[redacted]
Length of protection (m)	[redacted]	[redacted]	[redacted]
Total cost (£)	[redacted]	[redacted]	[redacted]
EV before risk reduction (per year)	[redacted]	[redacted]	[redacted]
EV After risk reduction (per year)	[redacted]	[redacted]	1.31E-05
Cost Per Casualty Averted (£Million)	[redacted]	[redacted]	[redacted]

15.8.6 Of the different lengths described above, it is the view of National Gas that the engineering judgement option, 421m, is the preference for this location. This extends the slabbing beyond the boundaries of the caravan site and provides a balance of protecting the entirety of the caravan park area whilst limiting the costs of the mitigation measures. At this location National Gas intend to use concrete slabbing inside the boundary of the caravan park and either plastic slabs or mesh in the fields either side.

Location 4: [redacted]

15.8.7 Figure 20 shows the FN curve for this location. The risks extend beyond the risk criterion as defined in TD/2 and this confirmed a CBA was required.



[redacted]

Table 35 [redacted]

Parameter	Risk Reduction Option – Concrete Slabbing		
	Length for minimum CPCA	Engineering Judgment	Removing the Infringement
Location of protection	[redacted]	[redacted]	[redacted]
Length of protection (m)	[redacted]	[redacted]	[redacted]
Total cost (£)	[redacted]	[redacted]	[redacted]
EV before risk reduction (per year)	[redacted]	[redacted]	[redacted]
EV After risk reduction (per year)	[redacted]	[redacted]	[redacted]
Cost Per Casualty Averted (£Million)	[redacted]	[redacted]	[redacted]

15.8.8 Of the different lengths described above, it is the view of National Gas that the engineering judgement option, 99m is the preference for this location. This extends the slabbing north until benefit per metre decreases such that the benefit is no longer proportionate to the costs of installation. This balances costs now whilst providing protection against creeping development in the future.

15.9 Appendix 9 – Cost Breakdown

Intervention Name	External Cost	External %	NG Cost	NG %	Pre build Cost	Pre build %	Materials, Plant & Equipment cost	Materials, Plant & Equipment %	Risk & Contingency cost	Risk & Contingency (% of total cost)	Total
RDOC Defect Mitigation- Fencing and Ditch Board Installation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]
RDOC Defect resolution- Topsoil Importation			[redacted]	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Watercourse crossings defect resolution	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			[redacted]
[redacted]			[redacted]	[redacted]			[redacted]	[redacted]			[redacted]