national gas transmission

ENGINEERING JUSTIFICATION PAPER (EJP)

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Pipeline

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RIIO-GT3 NGT_EJP17

Contents

1 Summary Table

Table 1: Pipeline - Pipeline EJP Executive Summary Table

Name of Project	*Pipeline*		
Scheme Reference	NGT_EJP017_Pipeline_RIIO-GT3		
Primary Investment Driver	*Asset Health*		
Project Initiation Year	*FY27*		
Project Close Out Year	*FY31*		
Total Installed Cost Estimate (£)	£77.7		
Cost Estimate Accuracy (%)	+/- 10%		
Project Spend to date (£)	0		
Current Project Stage Gate	ND500 Stage 4.0		
Reporting Table Ref	6.4		
Outputs included in RIIO-T2 Business Plan	*Yes*		
Spend Apportionment (£m)	**RIIO-T2**	**RIIO-GT3**	**RIIO-GT4**
	1.7	75.5	0.5

2 Executive Summary

2.1.1 This paper requests £77.7m (2023/24) of baseline funding in RIIO-GT3, measured through an Asset Health - NARMs PCD. This is for Pipeline integrity investments on our buried pipeline assets to comply with legislation. This investment is linked with Cathodic Protection programme of works, to manage pipeline integrity which are covered in a separate but linked EJP. Table 2 below table summarises the split of funding requested between this EJP and the associated NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3

Table 2: Funding requested £m (2023/24)

EJP	Funding Request
This EJP (Pipeline)	77.7
Associated EJP (Pipeline- Cathodic Protection) – Baseline Request	43.4
Associated EJP (Pipeline- Cathodic Protection) –Volume Driver Request	25.6
Total	**146.7**

2.1.2 The primary driver for this investment is compliance with statutory legislation. We have an obligation to complete the necessary inspection and maintenance activities to manage the process safety risks, such as loss of containment, that are associated with operating high-pressure (HP) natural gas pipelines.

2.1.3 289 interventions are required to comply with legislation and to maintain stable risk levels during RIIO-GT3. The spend proposed in this EJP will be assessed via NARMS methodology.

2.1.4 We have considered 13 types of interventions across the pipeline portfolio to ensure its integrity. In summary we are proposing the following intervention mix:

Table 3: RIIO-GT3 volumes proposed in this EJP

	Pipeline Inspection	Pipeline Defect Remediation	Legacy Flow Stopping Device	Easement Reinstatement Campaign	Total
RIIO-GT3 volume	104	178	7	437.805km	289 and 437.805km

2.1.5 Overall, RIIO-GT3 spend has increased when compared to RIIO-GT2 due to the inclusion of Easement Reinstatement Campaign (ERC) to manage vegetation in the easement of our pipelines, driven by an action legal received HSE. Changes between RIIO-T2 business plan and forecast delivery is driven by the movement of pipeline inspections to be undertaken increasing as we refresh condition data into our Intervals inspection planning tool.

Table 4: RIIO-T2 vs RIIO-GT3 (£m, 2023/24)

	RIIO-T2 Business Plan	RIIO-T2 Forecast Delivery	RIIO-GT3 Business Plan
Interventions	366	438	289 and 437.8km
Investment	£57.74m	£62.84m	£77.7m

2.1.6 Due to this work being required to meet legislation, the worklist contained within this EJP sets the outages required during RIIO-GT3. The remaining RIIO-GT3 portfolio of works are then programmed to fit around these statutory inspections. The profile of pipeline integrity investments for RIIO-GT3 is shown in the table below.

Table 5: RIIO-GT3 funding request for Pipeline integrity investments (£m, 2023/24)

Intervention	2026	2027	2028	2029	2030	2031	2032	Total
Easement Reinstatement Campaign (Scrub Clearance)		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		**5.13**
In Line Inspection (Pipeline PSSR Inspection)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**18.99**
In Line inspection Defect Digs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**30.00**
Legacy Flow Stop Device Investigation	[redacted]	[redacted]	[redacted]					**0.94**
Legacy Flow Stop Device Remediation		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		**1.14**
OLI/4 (Pipeline PSSR Inspection)	0.01	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**0.22**
OLI/4 Pipeline Defect Remediation			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**4.09**
Easement Reinstatement Campaign (Tree Clearance)		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		**16.53**
Bacton Road Crossing – Integrity Inspection			[redacted]	[redacted]	[redacted]			**0.63**
Total	**1.72**	**14.27**	**11.69**	**18.25**	**15.77**	**15.49**	**0.50**	**77.7**

3 Introduction

3.1.1 Pipelines are the primary asset within the National Transmission System (NTS) that enables transportation of gas and maintaining their integrity is critical to safe and reliable operation.

3.1.2 The design, construction, operation, inspection, and maintenance of our pipelines follow the requirements of the Pressure System Safety Regulations 2000 (PSSR) and Pipeline Safety Regulations 1996 (PSR). National Gas Transmission (NGT) follow industry standards IGEM/TD/1 and our maintenance policies and procedures list our pipeline management practises to ensure compliance with legislation.

3.1.3 We have an obligation to complete the necessary maintenance activities under these regulations, to manage the process safety risks that are associated with operating high-pressure natural gas pipelines.

3.1.4 The UK Health and Safety Executive (HSE) use IGEM/TD/1 as the measure for compliance with PSSR and PSR. Failure to meet the requirements of IGEM/TD/1 will result in enforcement action from the HSE.

3.1.5 This justification paper will cover the following themes:

- Internal Pipeline inspection using In-Line Inspection (ILI)
- External Pipeline inspection where ILI is not possible (OLI/4)
    - Traditional non-in-line inspectable pipelines
    - Bacton Road Crossings
- Remediation of pipeline corrosion features
- Legacy flow stopping installations.
- Management of vegetation and trees in the pipeline easement

3.1.6 Our investment proposals are built on robust data that has been gathered over many years. Our programme is driven by primary legislation and managed through an accepted methodology agreed with the HSE. The most cost-efficient solution is a regime of internal and ground-based surveys combined with associated remedial works to ensure we comply with legislation and prolong the life of our assets.

3.1.7 This EJP has been structured as shown in the below figure to cover three sub-themes:

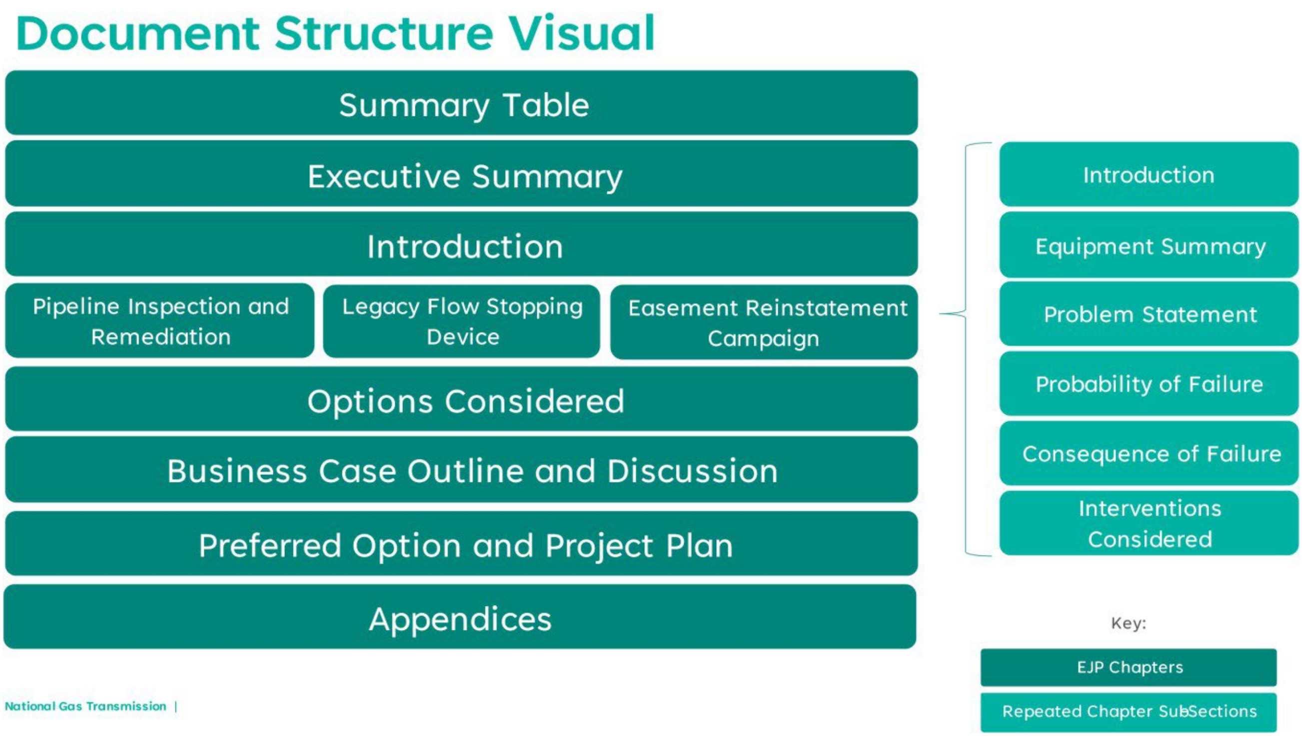


Figure 1: EJP Document Layout

3.1.8 This EJP interacts with other EJPS in the submission which are listed below:

- NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3 - performance of the Cathodic protection system affects the rate of corrosion growth and impacts upon the number of In-line inspections required.
- NGT_EJP18_Pressure Vessels_RIIO-GT3 - These assets are required to enable the in-line inspection of pipelines. If PIG Traps are not available for use, alternative pipeline inspection methods will have to be used.
- NGT_EJP22_Valves: Valves_RIIO-GT3 and NGT_EJP23_Valves: Actuators_RIIO-GT3 - Required to enable outages, isolations in response to incidents and safety to operators when using pressure vessels.

3.1.9 The scope of this document is aligned with our Asset Management System (AMS) and relates to our Business Plan Commitments (BPCs): meeting our critical obligations every hour of every day and delivering a resilience network fit for the future. More information on our AMS is provided in our NGT_A08_Network Asset Management Strategy_RIIO_GT3 annex and our BPCs are detailed within our NGT_Main_Business_Plan_RIIO_GT3.

4 Pipeline Inspection and Remediation - £53.9m (2023/24)

4.1 Introduction

4.1.1 This chapter details the interventions we must perform to ensure the safety, integrity, and reliable operation of our buried transmission pipelines.

4.1.2 We have developed these on-going investments to maintain the availability, performance, and integrity of the NTS pipeline system. Any significant pipeline replacement or diversion programmes will not be cost efficient for our consumers. A regime of ILIs and ground-based surveys, combined with investment in effective Coating and Cathodic Protection (CP) Systems and the associated investigation and remedial work, is by far the most cost-efficient solution to manage the long-term health and legal compliance of these critical assets.

4.2 Equipment Summary

4.2.1 There are over 7,600 km of steel pipelines in our NTS that are designed to convey gas at specified pressures. The majority of these assets have diameters ranging from 900mm to 1200mm, and a maximum operating pressure (MOP) ranging from [redacted]. Global summary data for the NTS pipeline population is available in the pipeline data book available in Appendix 5.

4.2.2 Most of these assets are buried with some sections above ground, or through exposed pits, typically within AGIs or block valves. Although in many places we have duplicate feeders, it is still challenging to arrange outages and some sections have no back-up in which case we rely on Distribution Networks (DNs) making substitutions between offtakes etc. Further asset information on our pipeline assets in the NTS can be found in our internal publication NTS Pipeline Databook upon request.

4.2.3 The design, construction, operation, and maintenance of the Pipeline is subject to both PSSR and PSR. More detail on these can be found in Appendix 1 in section 10.1.

4.2.4 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_IDP06_Portfolio EJP Pipeline_RIIO-GT3.

In-line inspectable Pipelines

4.2.5 As over 95% of the pipeline is buried, most inspections are internal and carried out using ILI equipment. The purpose is to determine the structural condition of the pipeline providing an accurate description of any metal loss and other defects. Any defects identified require consideration, investigation, and resolution within PSSR timescales. This can involve exposing the pipeline to assess the damage and to identify the remediation work.

4.2.6 ILIs are carried out at defined intervals. NGT use an industry standard risk-based scheduling tool called Intervals 2, which has been designed to determine the interval to the next ILI based on an estimate of corrosion growth rates, pipeline wall thickness, and stress level in the pipe wall. To do this, Intervals 2 uses pipeline and operational data in conjunction with current and historical Cathodic Protection inspection and test results to establish a rate of degradation and therefore predict when the next inspection is due. This leads to a dynamic interval between each ILI.

Non in-line inspectable Pipes

4.2.7 There are 31.82km of pipelines that cannot be internally inspected via ILI. This is due to pipeline configuration (not allowing either access to insert ILI equipment or sufficient flows to drive the ILI tool) or there is not a Pipeline Inspection Gauge (PIG) for the diameter of this pipe.

4.2.8 The majority of these are managed using condition assessment tools. Defects on these pipeline sections are inferred from a combination of a Close Interval Potential (CIP) survey of the effectiveness of the CP system and an electrical survey of the pipeline to check coating integrity. Any abnormalities identified are combined with other data such as line walk and aerial surveillance results to undertake a risk-based assessment to determine the investigation and remediation timescales. Due to the nature of the survey techniques, limited information is available without exposing the pipeline, therefore all except the lowest risk abnormalities will require excavation.

4.2.9 Where we are unable to monitor condition by electrical surveys, we undertake direct assessment of the pipeline.

This involves excavation to expose the pipeline and a physical assessment and measurement of corrosion features. This occurs at pipelines that are laid at a depth which non-invasive tools are unable to penetrate the ground cover above the pipeline.

4.3 Problem/Opportunity Statement

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

4.3.1 The failure of a pipeline would directly impact our ability to meet our obligations to our customers and wider Security of Supply as the NTS is part of the UK's Critical National Infrastructure (CNI). It would also pose a significant safety risk to our employees and members of the public.

4.3.2 Our buried steel pipelines account for 99.9% of all buried pipework on the NTS and are designed to convey gas at specified pressures, whilst meeting legislative and safety requirements.

4.3.3 Corrosion of buried steel pipelines is the most significant life limiting factor. Pipeline coating provides primary corrosion protection for all pipework by limiting or preventing the metal substrate from coming into contact with any harmful long-term effects of the environment and/or electrolyte that the pipe is immersed in or exposed to. However, coating systems deteriorate with age, with each type having different rates and characteristics and presenting different issues for resolution. More defects are becoming evident on the older coatings.

4.3.4 Cathodic Protection (CP) is installed along the length of the pipelines as secondary protection to prevent corrosion where the coating has failed. The performance of CP systems impacts upon corrosion rates. Our investment proposals for managing pipeline CP systems are in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

4.3.5 The most economic approach for the management of our pipeline is through our existing inspection regime to understand the integrity of the pipeline and targeted remediation.

4.3.6 The drivers for investment in our Pipelines include those summarised in Table 6.

Table 6: Categories of driver for Pipelines

Driver Category	Description
Legislation	Compliance with the Pressure System Safety Regulations (PSSR) 2000 and Pipeline Safety Regulations (PSR) 1996.
Safety	As a responsible gas operator, we ensure to deliver the required network capability safely as a potential pipeline leak or rupture could lead to catastrophic impacts.
Asset Health Deterioration	Corrosion as the primary degradation mechanism is prevented as much as possible by maintaining coating protection and cathodic protection. This is supplemented by robust inspections and addressing any deterioration identified.

4.3.7 If we do nothing, NGT would not be operating to license agreements and would be operating in breach of legislation. A lack of pipeline inspections in accordance with their written schemes of examination would be a HSE reportable breach of operations and would result in the requirement to de-pressurise/isolate our pipeline systems as we could not validate the integrity of the pipelines. Corrosion defects would grow to a level where the integrity of the NTS cannot be maintained, and any level of remediation would not keep pace with degradation. This would place the NTS in a state where only significant asset replacement would counter the corrosion issues.

What is the outcome that we want to achieve?

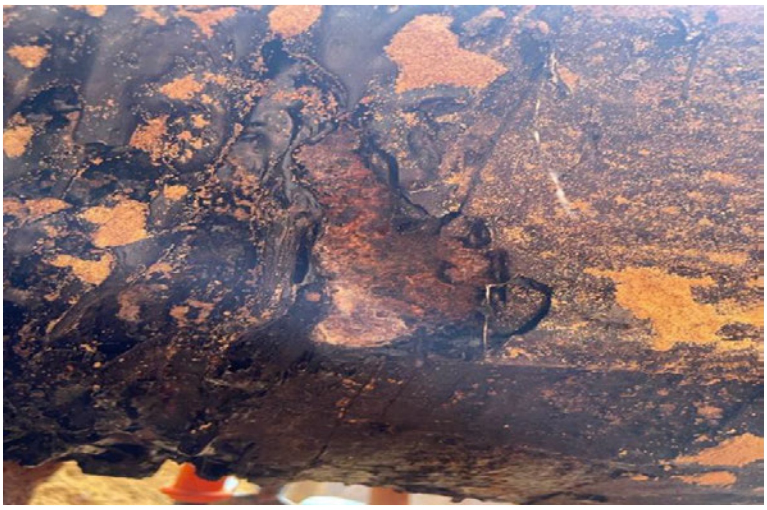
4.3.8 Within RIIO-GT3, the outcome NGT want to achieve is continued compliance with legislation to enable continued safe operation of pipeline assets.

How will we understand if the spend has been successful?

4.3.9 Defects identified during inspections are remediated within two years after the inspections as required by legislations.

Narrative Real Life Example of Problem

4.3.10 An excavation at [redacted] revealed coating failures and corrosion defects. One example of this is shown in the below image.



[redacted]

4.3.11 Left unresolved, this feature will continue to corrode to a point in which the integrity of the pipeline becomes compromised which will result in a rupture and loss of containment of gas.

Project Boundaries

4.3.12 The proposed investments within this EJP comprise of statutory inspections of the pipeline to assess their condition and identify corrosion defects requiring remediation. This EJP covers all buried transmission pipelines on the NTS, including pipeline sections connected to St Fergus.

4.3.13 This EJP does not include:

- The Pipeline Inspection Gauges (PIGs) – NGT are not responsible for these as they are hired in from an external supplier when required, with the supplier responsible for PSSR compliance.
- Investments for PIG Traps which are covered in NGT_EJP18_Pressure Vessels_RIIO-GT3**.**
- Investments for Hydrogen in-line inspections prior to re-purposing decisions.
- Additional cost of enhanced ILI, where deemed necessary, to identify AC corrosion which is covered in NGT_EJP08_AC Inspection and Remediation_RIIO-GT3.
- Non-intrusive surveys of the pipeline focused on CP performance, repair of pipeline coating and replacement or upgrade of CP systems or its components which are covered in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

4.4 Probability of Failure

4.4.1 The failure modes for pipeline are:

- Corrosion - Degradation of the metal due to the mechanics of corrosion.
- Third Party - External parties rupturing the pipeline by physical works in the vicinity of the pipeline.
- Wear - Failure due to the pipeline experiencing movement and vibrations rubbing against other causing damage.
- Fatigue - Cracks that develop due to repeated stresses.

4.4.2 The main failure mechanism for pipeline is corrosion. The predicted number of pipelines failures due to a lack of investment in the remediation of coating defects across the NTS is shown in Figure 3.

Predicted Nr of Pipeline Failures Arising from Corrosion Defects

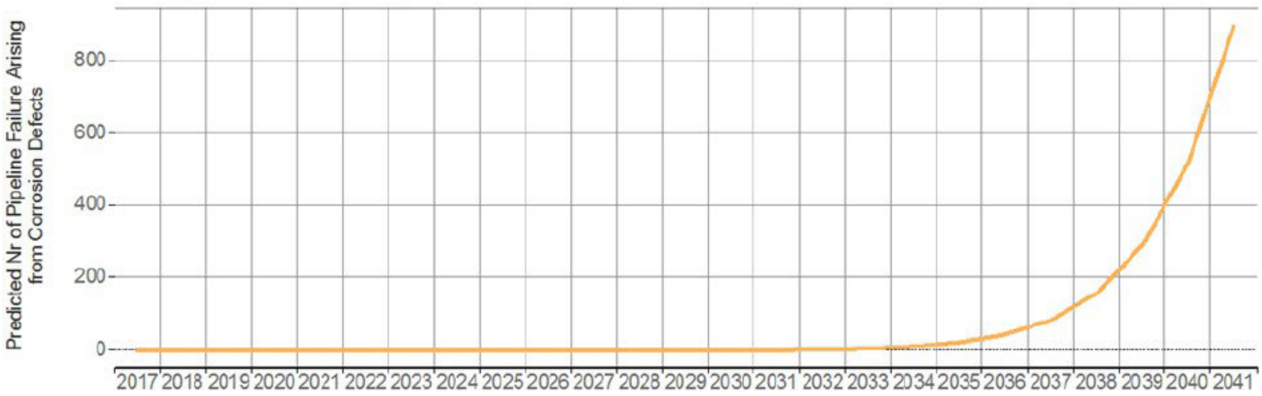


Figure 3: Probability of NTS failure due to lack of investment

4.4.3 The volume of defects requiring excavation to repair following previous In-Line inspections are provided in the below table. Data for 2022 and 2023 was not available at the point of creation of the below table:

Table 7: Post ILI outcome summary

Inspection Year	Total Number of Inspection	Total Length Inspected (km)	Total Digs undertaken
2011	27	1818.31	81
2012	21	1078.9	49
2013	20	933.05	39
2014	13	580.965	18
2015	12	784.98	38
2016	13	670.93	40
2017	12	694.72	37
2018	8	379.52	8
2019	15	1047.741	20
2020	19	886.84	42
2021	22	1071.41	29

Probability of Failure Data Assurance

4.4.4 The data modelling tool we use to determine the frequency of ILI inspections, Intervals 2, is developed by specialist pipeline engineers and used by all UK Gas Transmission and Distribution Operators. This takes a risk based approach using data we hold for historic ILI inspections, CP system performance and defects. It has been ratified by HSE as "accepted practice".

4.4.5 OLI/4 inspection is a time-based intervention (every 5 years) calculated from the last inspection date for all non-in-line inspectable pipelines and based on data we hold centrally for historic OLI/4 inspections and defects.

4.5 Consequence of Failure

4.5.1 In the event of a pipeline failure, this would be a significant emergency event to isolate the pipeline and resolve the immediate event. The pipeline would need to be isolated whilst an investigation occurs, impacting on the ability to operate the NTS. At locations which are fed by a single pipeline, there could be a loss of gas supply whilst service is restored.

4.5.2 The table below indicates the expected impacts should any failures occur on a buried transmission pipeline.

Table 8: Consequence of Failure Summary

Asset	Environment	Financial	Availability	Safety
Pipeline	The release of gas arising from a leak or rupture of the pipeline, caused by external interference, corrosion or other failure modes would	There would be a significant financial impact of a large-scale failure or loss of service event. This could include loss of revenue, compensation,	The shut-down of a pipeline to repair a leak or rupture caused by corrosion requires outages which can result in loss of supply to customers.	A pipeline leak or rupture caused by corrosion is a significant safety concern. Where the pipeline passes near centres of population

	have a negative impact on the environment with Methane being 28 times more harmful than Carbon dioxide to the contribution of climate change. This is further discussed in NGT_EJP21_Network Decarbonisation_RIIO-GT3	cost to repair the asset and fines.	Dependant on the scale of loss of supply, this can have a knock-on impact on the wider economy such as industrial clusters being unable to manufacture and health impacts for people in high-risk groups.	risk of ignition of the leak or rupture is relatively large.

4.6 Interventions Considered

Pipeline Survey Interventions

4.6.1 Four interventions were considered for surveying conditions of our buried pipeline assets.

Counterfactual (Do nothing)

4.6.2 This option involves undertaking no capital investment to determine the conditions of our pipeline assets internally and externally.

4.6.3 The counterfactual intervention considers no specific action to be undertaken in RIIO-GT3 over and above our usual Pipeline maintenance and repair to meet the minimum level of intervention that would be required to remain complaint with all relevant safety regulations. As the Pipelines deteriorate, NGT will carry at increased risk for the pipeline network.

4.6.4 This intervention has been ruled out as we would not be compliant with our statutory obligations as a responsible operator. The level of risk is not tolerable and would leave the NTS vulnerable to integrity failure.

Pipeline PSSR In-Line Inspection (ILI)

4.6.5 A periodic condition monitoring activity to inspect a pipeline from the inside using an ILI tool as it travels through the pipeline. The ILI tool collects various forms of data using sensors and electronics about the condition of the pipeline from the inside.

4.6.6 No outage or pressure reduction is required to carry out this intervention.

4.6.7 Interval of an ILI is determined by Intervals 2, an industry approved risk-based approach.

Pipeline PSSR OLI/4 Inspection

4.6.8 This option is a periodic condition monitoring activity via ground based electrical and visual survey of the Pipeline and its environment for those Pipelines that cannot be inspected using an ILI. An OLI/4 inspection is carried out every 5 years.

4.6.9 No outage or pressure reduction is required to carry out this intervention.

Bacton Road PSSR OLI/4 Inspection

4.6.10 NGT sought advice from [redacted] on how to inspect the [redacted] 'unpiggable' road crossing assets. Based upon the pipeline attributes, depth and lack of access, [redacted] determined that direct inspection by excavation was the only feasible method of inspection after consideration of other techniques such as long-range ultrasonics techniques (LRUT).

4.6.11 No outage is required to carry out this intervention however we would need to reduce pressure to 85% to facilitate this inspection.

Pipeline Remediation Interventions

4.6.12 Three interventions were considered for remediating a pipeline when a defect is identified by an ILI or OLI inspection.

Counterfactual (Do nothing)

4.6.13 This option involves undertaking no capital investment to determine the remediation required for the defect identified in an ILI or OLI inspection.

4.6.14 This option has been ruled out as we would not be compliant with our statutory obligations as a responsible operator. The level of risk is not tolerable and would leave the NTS vulnerable to integrity failure.

PSSR – ILI and OLI/4 Inspection Defect Remediation

4.6.15 Only ILI defects that present a current threat to structural integrity (based on damage criteria defined in industry recognised policies) or have the potential to do so before the next ILI are further investigated. An expert risk-based judgement is taken following an OLI/4 inspection to decide whether the survey results indicate an integrity threat that requires investigation.

4.6.16 The pipeline is exposed at the point of a defect indicated to determine the existence, actual size, and nature of the damage. This enables us to determine the appropriate remediation action to take. Defect resolution must be performed within 2 years of the respective inspection.

4.6.17 ILI Defect Dig and OLI/4 Pipeline Defect Remediation could result in any of the following action being undertaken whilst excavating. This is driven by the level of residual strength in the pipeline and therefore the intervention required to ensure that the pipeline continues to be fit for purpose. The effect of types and nature of defects on the integrity of the pipeline have been developed based on historic and ongoing experimental destructive testing.

- **Coating Repair** - The excavation of the pipeline, the preparation of the surface and application of an appropriate coating to reinstate the primary protection against corrosion.
- **Pipeline Repair** - For the minor redressing of the pipeline and reinstatement of the coating for external corrosion of the pipeline and external interference damage.
- **Pipeline Refurbishment** - For external corrosion of the pipeline and external interference damage more significant issues can be resolved by the installation of a shell or clamp over the pipeline and the reinstatement of the coating.
- **Replacement of Pipeline Section** - For significant external corrosion, external interference damage or internal corrosion, a section of the pipeline can be replaced which consists of Pipeline isolation and shutdown, vent inventory, purge, cut out affected section and weld in replacement, reinstate coating and recommission.

4.6.18 Excavation of below ground pipework is a significant undertaking. Pipelines are typically installed at a depth of 1.5 metres resulting in an excavation being suitably sized to install trench support systems. Investigation of a corrosion defect will require a pressure reduction to reduce the stress on the pipeline prior to investigation. Due to the integrated nature of the NTS, this will normally result in a pipeline outage.

4.6.19 Significant **pipeline replacement** or **coating repair** are extremely expensive interventions. Therefore, the internal and ground-based surveys combined with effective Cathodic Protection and the associated investigation and remedial work is by far lowest whole life cost/risk solution to managing the long-term health and performance of this critical asset.

4.6.20 Outage or pressure reduction may be required depending on the type of remediation required based on inspection reports.

Interventions Summary

4.6.21 Table 9 summarises the interventions considered for pipeline inspection and remediation.

Table 9: Interventions considered for pipeline inspection and remediation on our buried pipeline assets (£m, 2023/24)

Intervention	Equipment Design Life	Positives	Negatives	Taken Forward
Counterfactual (Do nothing)	0	• There is no CAPEX investment required for assessing the integrity of our buried pipeline assets.	• Non-compliant with requirements of legislation due to failure to perform a PSSR inspection. • Enforcement action from HSE and prohibition of use of pipeline network	No
Pipeline PSSR In-Line Inspection (ILI)	40 years	• Compliant with legislation • ILI is the standard of inspection expected to be achieved where possible by HSE. • Determines whether the pipeline is in an appropriate condition to meet the required duty. • Determines metal loss due to mechanical defects, external corrosion, mechanical interference (gouges and dents), and other mechanisms. Informs our inspections and remediation strategy	• Requires specific network configuration to run tools. • Not currently an option for 100% of the NTS (0.4% of the NTS is not in-line inspectable)	Yes
Pipeline PSSR OLI/4 Inspection	40 years	• Compliant with legislation • Accepted as appropriate where ILI cannot be performed. • Informs us whether external interference has occurred. • Informs future inspections and remediation strategy.	• Less comprehensive than ILI • Results are indicative and often require more intrusive remediation to fully understand potential pipeline damage.	Yes
Bacton Road Crossing Inspection	40 years	• Same as Pipeline PSSR OLI/4 Inspection	• Same as Pipeline PSSR OLI/4 Inspection	Yes
PSSR – ILI Inspection Defect Dig	40 years	• Compliant with legislation • Appropriate management of a PSSR defect • Addressing defects found promptly can extend asset life, reduce risks, and ensure a secured supply of gas	• Remediation may require outage and excavation. • Expensive intervention	Yes
PSSR - OLI/4 Pipeline Defect Remediation	40 years	• Compliant with legislation • Appropriate management of a PSSR defect • Addressing defects found promptly can extend asset life, reduce risks, and ensure a secured supply of gas	• Remediation may require outage and excavation. • Expensive intervention	Yes

Volume Derivation

4.6.22 The table below summarises the derivations of volumes per inspection proposed.

Table 10: Volume derivation of pipeline inspection and remediation interventions

Intervention	Volume	Unit of Measure	How this volume has been developed
Pipeline PSSR In-Line Inspection (ILI)	72	Inspection	To increase the accuracy of the frequency of each ILI, and subsequently the volume of ILIs across the 10 years on Intervals 2, we modified the age of the asset and resistance to corrosion of our Pipeline assets on Intervals 2 to evaluate the impacts that would have on the ILI frequencies generated. This informs us a probable view of ILI schedule to be generated at the start of RIIO-GT3.
Pipeline PSSR OLI/4 Inspection	31	Inspection	OLI/4 inspection is a time-based intervention (every 5 years) calculated from the last inspection date for all non-inline inspectable pipelines and based on data we hold centrally for historic OLI/4 inspections and defects.
Bacton Road Crossing Inspection	1	Project	Like OLI/4, a time-based intervention with a 5 yearly frequency.
PSSR – ILI Inspection Defect Dig	160	Project	A forecasted run rate of dig/km of pipeline surveyed was calculated to improve the accuracy of the risk-based approach to determine the volume of ILI digs might be required.
PSSR - OLI/4 Pipeline Defect Remediation	18	Inspection	Determined based on known issues and historical frequencies combined with a risk-based assessment of those pipelines that will be subject to the most significant and fastest corrosion growth.

Unit Cost Derivation

4.6.23 A summary of the unit costs for these interventions is provided in Table 11. Further breakdown of costs is provided in Appendix 2 in section 10.2.

Table 11: Intervention Unit Cost Summary Table (£, 2023/24)

Intervention	Unit of Measure	Unit Cost (£, 23.24)	Cost Accuracy	Number of Data Points	Source Data
In Line Inspection (Pipeline PSSR Inspection)	Per inspection	[redacted]	+/- 10%	51	Historical outturn
In Line inspection Defect Remediation	Per project	[redacted]	+/- 10%	54	Historical outturn
OLI/4 (Pipeline PSSR Inspection)	Per inspection	[redacted]	+/- 30	7	Historical outturn
OLI/4 Pipeline Defect Remediation	Per project	[redacted]	+/- 10%	7	Historical outturn
Bacton Road Crossing Inspection	Per inspection	[redacted]	+/- 10	1	Estimate at Cost of Completion

4.6.24 The cost for In Line Inspection (Pipeline PSSR Inspection) has been produced using 51 data points for historically delivered works. Of the 51 data points available we removed 3 outliers as those interventions saw initial costs but were subsequently rescheduled to be undertaken at a later date. Of the 48 remaining data points, two showed higher costs than the average. High levels of NORM were discovered on one run which resulted in an increase in cost to safely remove and dispose this material. [redacted] Given the cyclical nature of ILI runs, it was agreed with the Asset Management team that we are likely to experience similar situations in the future and as such all 48 data points should be used.

4.6.25 The cost data for In Line Inspection Defect Remediation covered 54 digs across 25 sections of pipe representing a cross section of diameters, and both coating and encapsulation was analysed. It was agreed with the business that with the exception of installation of a 100m long sleeve under a major road which attracted a particularly high cost, the remaining examples represented a true reflection of the future work mix with pipeline corrosion features likely to be identified in the forecasted work portfolio.

4.6.26 The cost data for OLI/4 Pipeline Defect Remediation was produced using 7 CIPs digs across 2 sections of pipelines on two different diameter pipes. This information was then used to calculate the unit cost. It was agreed that these represent a good reflection of the anticipated future work mix. All 7 costs are broadly similar and as such an average of them was used as the unit cost.

4.6.27 Our cost accuracies are determined based on the type of cost data available, the quantity of this data (i.e., the number of data points) and the similarity of the scope of these historical data points against our RIIO-GT3 investment programme.

5 Legacy Flow Stopping Device - £2.10m (2023/24)

5.1 Introduction

5.1.1 This chapter provides justification for our investigation and remediation investments on legacy buried bolted fittings associated with flow stop devices in RIIO-GT3.

5.1.2 A population of the historical pipeline modifications used a hot tap technique to make connection to a live pipeline rather than taking the pipeline out of service to break containment. Hot tapping utilises a series of hot tap tee installations to allow a flow stopping and bypass operation to take place. Also referred to as installation of a bifurcated stopple and bypass. This results in a combination of permanent buried welded and buried bolted fittings upon completion.

5.2 Equipment Summary

5.2.1 Sometimes it is necessary to use a hot tap technique to facilitate tasks such as relocation or expansion of existing pipelines, repair or installation of valves, ILI digs and new customer connections. The process is also used to drain off pressurised casing fluids and add test points or various sensors such as temperature and pressure monitors. More information on how flow stopping devices are used on the NTS can be found in Appendix 1 in section 10.1.

5.2.2 As this is a newly identified area in our asset base, we currently do not have information on this asset group and are proposing works to be done in RIIO-GT3 to help us build our asset knowledge of these assets. There are [redacted] pipeline construction sections associated with diversions, some of which will have been installed using flow stop and bypass technology.

5.2.3 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_IDP06_Portfolio EJP Pipeline_RIIO-GT3.

5.3 Problem Statement

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

5.3.1 It is sometimes necessary to make a connection to a pipeline. Where possible, this is carried out by taking the pipeline out of service. Prior to breaking containment, we must recompress the majority of the gas, vent the remainder to atmosphere, purge the pipeline with an inert gas to ensure that it is safe to cut into the pipeline to modify it. However, this activity has many disadvantages such as releasing harmful gases into the atmosphere and interrupting service to customers.

5.3.2 In certain circumstances, localised isolation of the pipework is preferred. This can be performed by using flow stopping tools which allow a localised isolation, avoiding a pipeline outage and minimising disruption to the wider network. Multiple flow stopping devices can be deployed in conjunction with a bypass arrangement to maintain flow. Flow stopping tools and any associated bypass rely on the installation of several permanent stopples on the pipeline which include bolted fittings.

5.3.3 Buried bolted fittings remaining in the ground present a possible risk of a gas leak. NGT propose to excavate on a sample of this population to assess the condition of these buried fittings to understand whether this risk is valid, and if we need to intervene to remove or remediate all of these buried bolted fittings or whether the risk is not material and they can remain.

5.3.4 If we do nothing, a buried bolted fitting presents a gas escape path resulting in an opportunity for a future gas escape requiring emergency repair.

What is the outcome that we want to achieve?

5.3.5 Inspect a sample of existing buried bolted fittings in the NTS to validate the risk and identify the type of buried fittings at risk of failure out of the entire buried fitting population.

5.3.6 Where there is evidence of a gas escape on the asset, a pipeline shutdown may be required to allow refurbishment of the seals and flange. In extreme cas[redacted]

How will we understand if the spend has been successful?

5.3.7 Legacy buried fittings surveyed and remediated where required.

Narrative Real Life Example of Problem

[redacted]

[redacted]

Project Boundaries

5.3.10 The proposed investments address a possible risk with a population of historically installed buried bolted fittings on hot tap tees associated with legacy flow stopping operations.

5.3.11 The boundary of this work is to expose, assess and remediate the buried bolted fitting only.

5.4 Probability of Failure

5.4.1 As this is a newly identified area, we currently do not have this information, but we are gathering more data to inform future planning.

5.4.2 We know asset failure leading to gas leak is possible to occur due to the historic incident mentioned in 5.3.88.

5.5 Consequence of Failure

5.5.1 A buried bolted fitting presents a gas escape path resulting in an opportunity for a future gas escape requiring emergency repair.

5.5.2 The consequence of failure for our pipeline assets, specifically related to addressing legacy flow stopping devices, is presented below mapped against our NARMS Consequence of Failure service risk measures.

Table 12: Consequence of failure summary

Asset	Impact / Consequence			
	Environment	Financial	Availability	Safety
Pipeline	The release of gas arising from a leak or rupture of the pipeline, caused by external interference, corrosion or other failure modes would have a negative impact on the environment with Methane being 28 times more harmful than Carbon dioxide to the contribution of climate change. This is further discussed in the NGT_EJP21_Network Decarbonisation_RIIO-GT3.	There would be a significant financial impact of a large-scale failure or loss of service event which could be exacerbated if access were hindered. This could include loss of revenue, compensation, cost to repair the asset and fines.	The shut-down of a pipeline to repair a leak or rupture requires outages which can result in loss of supply to customers. Dependant on the scale of loss of supply, this can have a knock-on impact on the wider economy such as industrial clusters being unable to manufacture and health impacts for people in high-risk groups. This shut-down could be extended if access were hindered.	A pipeline leak or rupture is a significant safety concern. Where the pipeline passes near centres of population risk of ignition of the leak or rupture is relatively large. Any delay in addressing a leak or rupture would increase the safety impact.

5.6 Interventions Considered

Counterfactual (Do nothing)

5.6.1 This option does not involve any CAPEX work inspecting or remediating faulty buried bolted fittings. This has been discounted because of the potential risk of gas leak from faulty asset and the impacts that may have on the environmental, finance, safety and availability of the network as discussed in 5.5.

Legacy Flow Stopping Device - Investigation

5.6.2 Excavate and inspect five buried bolted fittings adjacent to historic construction projects where localised outage was required, typically on pipeline diversions and new customer connections.

5.6.3 Pressure reduction may be required to carry out this intervention.

Legacy Flow Stopping Device - Remediation

5.6.4 Where the investigation intervention finds evidence of a gas escape on a legacy bolted buried fitting, a pipeline shutdown may be required to allow refurbishment of the seals and flange. In extreme cases, we may need to break containment to replace the hot tap fittings with a new section of pipeline.

5.6.5 Outage may be required to carry out this intervention.

Interventions Summary

5.6.6 Table 13 summarises the interventions considered for legacy flow stopping devices.

Table 13: Interventions considered for legacy flow stopping devices

Intervention	Equipment design life	Positives	Negatives	Taken forward
Counterfactual (Do Nothing)	0	No CAPEX spend required	Little knowledge within the business on asset condition and locations Potential risk of gas leak from faulty asset and its associated impacts	No
Legacy Flow Stopping Device - Investigation	40	Increased asset health knowledge	May require outage or pressure reduction depending on network access that day	Yes
Legacy Flow Stopping Device - Remediation	40	Remove the potential risk of gas leak from faulty asset	May require outage or pressure reduction depending on network access that day	Yes

Volume Derivation

5.6.7 Development of bottom-up volumes of legacy flow stopping device interventions for RIIO-GT3 is summarised in the table below.

Table 14: Development of bottom-up volumes of legacy flow stopping device interventions for RIIO-GT3

Intervention	Volume	Unit of Measure	How this volume has been developed
Legacy Flow Stopping Device- Investigation	5	Per asset	There are 104 pipeline construction sections associated with diversions, some of which will have been installed using flow stop and bypass technology. Due to inspection and remediation of the buried bolted fittings requiring feeder outage and excavation, we propose to inspect a sample of these assets (a volume of 5) and remediate 2 which may be defective, to help us understand the scale of problem and this will support more refined plans in the future.
Legacy Flow Stopping Device- Remediation	2	Per asset	

Unit Cost Derivation

5.6.8 A summary of the unit costs for these interventions is provided in Table 15. Further breakdown of costs for the interventions is provided in Appendix 2 in section 10.2.

Table 15: Intervention Unit Cost Summary Table (£, 2023/24)

Intervention	Unit of measure	Unit Cost	Cost accuracy (%)	Number of Data Points	Source Data
Legacy Flow Stopping Device- Investigation	Per asset	[redacted]	+/-10	54	Historical outturn
Legacy Flow Stopping Device- Remediation	Per asset	[redacted]	+/-30	0	Estimate at Cost of Completion

5.6.9 The unit cost for legacy flow stopping device investigation has been based on RIIO-T2 costs delivered to date for **In Line inspection Defect Remediation** which has a comparable scope to this intervention.

5.6.10 The unit cost for legacy flow stopping device remediation has been based on estimates for **Insulation Joint Replacement** submitted in Plant and Equipment UM in January 2024, which has a comparable scope to this intervention.

6 Easement Reinstatement Campaign - £21.7m (2023/24)

6.1 Introduction

6.1.1 NGT are requesting funding to undertake a one-off Easement Reinstatement Campaign to target areas of the NTS where trees and vegetation have encroached on the rights of way. The purpose of this campaign is to achieve compliance with Gas Safety (Management) Regulations 1996. The legislation requires NGT to maintain clear easements so that the pipeline is accessible in the event of an emergency.

6.1.2 In November 2023, the HSE completed a pipeline intervention on the management of pipeline rights of way (easements). HSE findings both within NGT and across the wider pipeline industry were that there was a failing to appropriately manage the growth and onset of vegetation. In collaboration with the HSE, NGT conducted a detailed investigation to establish the root cause. The HSE have accepted the findings that guidance in legislation and industry standards was insufficient to drive appropriate behaviours across the industry leading to decades of inadequate funding, resourcing, and activity.

6.1.3 Following the HSE intervention, NGT has changed internal policy for the management of trees and vegetation within the easement, moving from a reactive (fix on find) position to a scheduled routine clearance. NGT will also be sharing this approach to better inform wider industry through a UKOPA good practice guide.

6.1.4 NGT has produced a new maintenance policy and suite of new maintenance activities to address the shortfall in historical industry performance.

6.1.5 This EJP seeks funding to remediate a historical position to enable a routine schedule of ongoing clearance as BAU.

6.2 Equipment Summary

6.2.1 The worklist contained within this EJP is the easements above all our NTS buried pipelines.

6.2.2 Controlling vegetation above our pipelines is necessary for legislative compliance. Well controlled vegetation ensures access to our pipeline assets for inspections and repairs. It also ensures marker posts remain visible and can be maintained as in-line with internal policy. This is vital for public safety and management of the risk of third-party interference.

6.2.3 Sightings of vegetation overgrowth are raised as defects in [redacted] via line walking surveys and aerial surveillance.

6.2.4 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_IDP06_Portfolio EJP Pipeline_RIIO-GT3.

6.3 Problem/Opportunity Statement

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

6.3.1 Historical practice to manage trees and vegetation relied on an inferred policy based around tree planting guidelines. Working with the HSE, NGT have demonstrated that the historical practices are inadequate to address the issue and that a new proactive approach is required.

6.3.2 An Action Legal was issued to NGT in November 2023 (see Appendix 3) regarding our maintenance of rights of way through areas of tree growth in accordance with the Regulation. In response to the Action Legal, we provided a programme of improvements to review data, identify scrub growth and develop a programme of works to address shortfalls. We have also reviewed our maintenance processes / systems and developed improvements to ensure ongoing management of these areas is embedded. The programme of works proposed in this EJP is required to comply with the actions agreed within the HSE Action Legal.

6.3.3 NGT has created a new vegetation management system outlined in maintenance procedure [redacted]. These guidelines are set out to ensure vegetation is well controlled, so that access to our pipeline assets is easier for inspections and repairs.

6.3.4 If we do nothing, we will fail to fulfil our HSE Action Legal and legislative obligation.

6.3.5 Furthermore, due the higher rainfall frequency and occurrence caused by climate change; the growth of vegetation is projected to increase due to the favourable growing conditions. If we do not carry out this investment, the risk is exacerbated by the impact of climate change. This is further discussed in our Climate Resilience Strategy Annex.

6.3.6 The benefits of improving our scrub management include:

- Ease of access to pipeline in case of emergency
- Reinstatement of line of sight between marker posts to aid aerial and land surveys and to clearly indicate location of our pipeline route to third parties, thereby reducing risk of third-party interference.
- Increased cost efficiency within pipeline surveys such as Close Interval Potential Surveys (CIPS) due to fewer missed sections and rework
- Clearer sighting of any dangerous encroachments in the vicinity of the pipeline
- Closer relationship with landowners and users due to increased presence on land

What is the outcome that we want to achieve?

6.3.7 Sufficiently clear easement around pipelines to ensure maintenance activities can be conducted efficiently and safely and ensure emergency access and visibility in line with HSE requirements.

How will we understand if the spend has been successful?

6.3.8 Successful spend will be realised when the 3m easement strip of NTS pipelines is cleared with all trees over 4 metres removed. This will be realised when all sections of pipeline can be observed via the helicopter flights.

6.3.9 The HSE shall be informed of our fulfilment of actions agreed. This will also prevent us from receiving more notices regarding safety regulations going forward.

6.3.10 An increased first-time-completion rate of our CIPS and reduction in missed sections during CIPS could also indicate the benefits from this investment have been achieved.

Narrative Real-Life Example of Problem

6.3.11 An initial desktop assessment was carried out to identify potential areas of overgrowth across our NTS. Surveys were then carried out to verify and obtain more information about the location, type and density of vegetation across the network. Two examples in this assessment are:

[redacted]

6.3.12 A mature Oak Woodland was identified along the [redacted] There is a definite easement through the woodland where only young self-seeded trees are growing, however, a 3m clearance is necessary.

[redacted]

6.3.13 Overgrowth was identified in a few locations along the [redacted]. Thick scrub and a number of mature trees were found in the 3m wide strip within easement.

[redacted]

Project Boundaries

6.3.14 The boundary of this project is delivery of vegetation clearance within 3m strip (1.5m either side of a pipeline) within easement in areas of the NTS where vegetation overgrowth has been observed up until the start of RIIO-GT3.

6.3.15 The investment scope does not include:

- Ongoing or minor ad-hoc vegetation clearance to maintain the level of vegetation to an acceptable level which will be opex funded.
- Clearance of vegetation outside of the 3m strip centred on the pipelines or around sites, this will be covered in ongoing OPEX funded vegetation clearance.
- Any data-gathering and monitoring activities to inform us of vegetation level such as line walking and aerial surveillance this will be funded via Opex.

6.4 Probability of Failure

6.4.1 The status of vegetation in the vicinity of our pipeline assets is not currently fully understood due to historically being unable to raise overgrowth defect against an asset in inspections and a lack of expertise in trees within the business.

6.4.2 Therefore, to increase our knowledge of the vegetation status over our NTS, the scale of the issue and the appropriate interventions required to resolve the issue, we have been working with [redacted], a company that provides satellite-derived geospatial analytics, to optimise our maintenance spending on vegetation clearance.

6.4.3 Other data gathering methods such as LiDAR, helicopter aerial surveys and visual inspections were also considered. Satellite imagery was chosen over the others for its cost-effectiveness and broad range of coverage.

6.4.4 A first pass of satellite imagery (from 2021 April to 2022 September growing season) and a second pass of satellite imagery (from 2023 April to 2024 May growing season) were gathered.

6.4.5 Images were then analysed to determine the vegetation type, location relative to our pipeline assets, vegetation health, vegetation height, vegetation growth rates and forecast of vegetation status in 2026.

6.4.6 Comparative tree, bushes and scrub coverage data between pass 1 and pass 2 was then used to estimate growth rates and generate predicted tree, bushes and scrub coverage status by the end of the growing season in 2026 in pass 3, a purely forecast set of data.

6.4.7 Results were categorised into anything with vegetation height less than 4m and more than 4m. Figure 6 is an extract of the summary report of pass 3 vegetation with a predicted height between 0m and 3.99m on [redacted] Figure 7 shows the locations of the vegetation with a predicted height between 0m and 3.99m.

Report details: Pass 3. 12m Asset Data. Trees and Bushes and Scrub between 0 and 3.99m in height <=1.5m either side of the line. Asset/Event View. Merge 1m

View by: Event | Asset

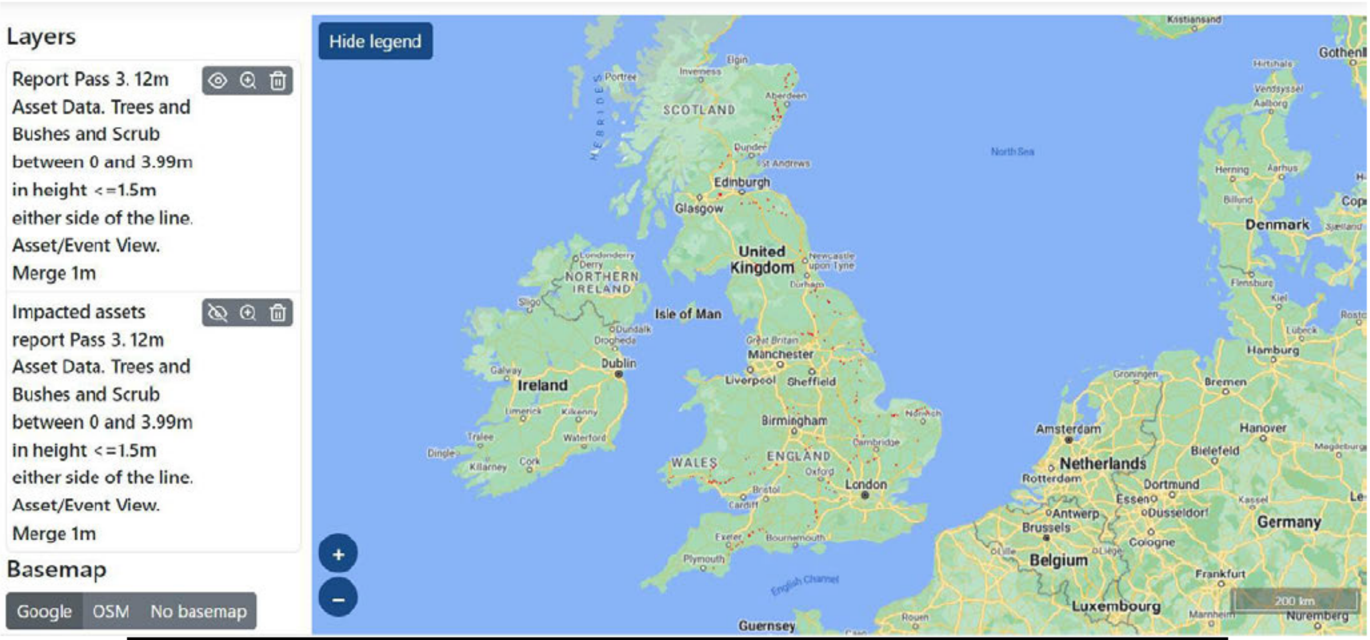
View mode: Table | Map

Export | Export Geojson

Show filters

	Asset name	Event count	Minimal horizontal distance to asset [m]	Estimated volume [m³]	Estimated area [m²]	Estimated length asset impacted [m]	Estimated asset length impacted [%]	Total length of asset [m]	Asset type	Asset Category	Asset Location	Location subgroup
	2077	1	0	13.45	13.45	7.33	61.05	12	GRTA05		000000983069	FEEDER 5
	2093	1	0	2.84	2.84	2.32	19.31	12	GRTA05		000000983069	FEEDER 5
	2094	1	0	20.94	20.94	10.53	87.76	12	GRTA05		000000983069	FEEDER 5
	2121	1	0	13.21	4.4	2.52	21.02	12	GRTA05		000000983069	FEEDER 5
	2122	1	0	13.09	4.36	2.53	21.08	12	GRTA05		000000983069	FEEDER 5
	2124	2	0	16.84	5.61	3.05	25.44	12	GRTA05		000000983069	FEEDER 5
	2144	1	0	17.26	5.75	2.45	20.41	12	GRTA05		000000983069	FEEDER 5
	2145	1	0	55.17	18.39	12	100	12	GRTA05		000000983069	FEEDER 5

[redacted]



[redacted]

6.4.8 The predicted view at start of FY27 of lengths of the NTS with vegetation in different height categories are summarised below.

Table 16: Predicted view of vegetation over the NTS at start of FY27 using satellite-derived geospatial analytics

Vegetation height (m)	Length of asset (km)	Percentage of the NTS
0 < x < 4	[redacted]	[redacted]
x > 4	[redacted]	[redacted]
x < 0	[redacted]	[redacted]

6.4.9 In order to improve the data we collect going forwards, we have created new categories such as Woodland and Pipeline Crossing Vegetation on [redacted] so that overgrowth defects can be raised against an identified asset. Furthermore, we have implemented changes on our Line Walking [redacted], to gather more useful and accurate defect data.

6.5 Consequence of Failure

6.5.1 Uncontrolled vegetation growth in the vicinity of our pipelines may have the following consequences which could lead to subsequent impacts to security of gas supply to the UK and mainland Europe:

- **Third-Party Interference:** Less clear sighting of any dangerous encroachments in the vicinity of the pipeline could impede us from intervening to prevent third-party interference. Inadequate indication of the location of our pipeline route to third parties could also increase the risk of third-party interference. Third party interference is the single greatest threat to our pipelines and can result in costly damage, or at worst a pipeline rupture.
- **Emergency Access:** Difficulty in accessing a pipeline in the case of an emergency could lengthen the overall duration of the incident, increasing the volume of gas lost to atmosphere and impact on supplies.
- **Inefficient Inspections:** Lack of visibility of the pipeline can result in missed sections and therefore rework which means an overall reduction in cost efficiency

6.5.2 The consequence of failure for our pipeline assets, specifically related to the clear easement, is presented below mapped against our NARMS Consequence of Failure service risk measures.

Table 17: Consequence of failure summary

Asset	Impact / Consequence			
	Environment	Financial	Availability	Safety
Pipeline	The release of gas arising from a leak or rupture of the pipeline, caused by external interference, corrosion or other failure modes would have a negative impact on the environment with Methane being 28 times more harmful than Carbon dioxide to the contribution of climate change. This is further discussed in NGT_EJP21_Network Decarbonisation_RIIO-GT3.	There would be a significant financial impact of a large-scale failure or loss of service event which could be exacerbated if access were hindered. This could include loss of revenue, compensation, cost to repair the asset and fines.	The shut-down of a pipeline to repair a leak or rupture requires outages which can result in loss of supply to customers. Dependant on the scale of loss of supply, this can have a knock-on impact on the wider economy such as industrial clusters being unable to manufacture and health impacts for people in high-risk groups. This shut-down could be extended if access were hindered.	A pipeline leak or rupture is a significant safety concern. Where the pipeline passes near centres of population risk of ignition of the leak or rupture is relatively large. Any delay in addressing a leak or rupture would increase the safety impact.

6.6 Interventions Considered

6.6.1 Three interventions were considered to address the problem statement.

Counterfactual (Do nothing)

6.6.2 This option involves no CAPEX activity. NGT shall continue monitoring the vegetation levels near our pipeline assets in the NTS with existing line-walking inspections and aerial surveys, and remediation practises. This is not acceptable because NGT would fail to fulfil HSE's Action Legal and legislation compliance.

Easement Reinstatement Campaign (Tree Clearance)

6.6.3 This option involves removing all trees **over 4m** high within the 3m strip (1.5m either side of a pipeline). This is indicated by the area between the two red lines in Figure 8.

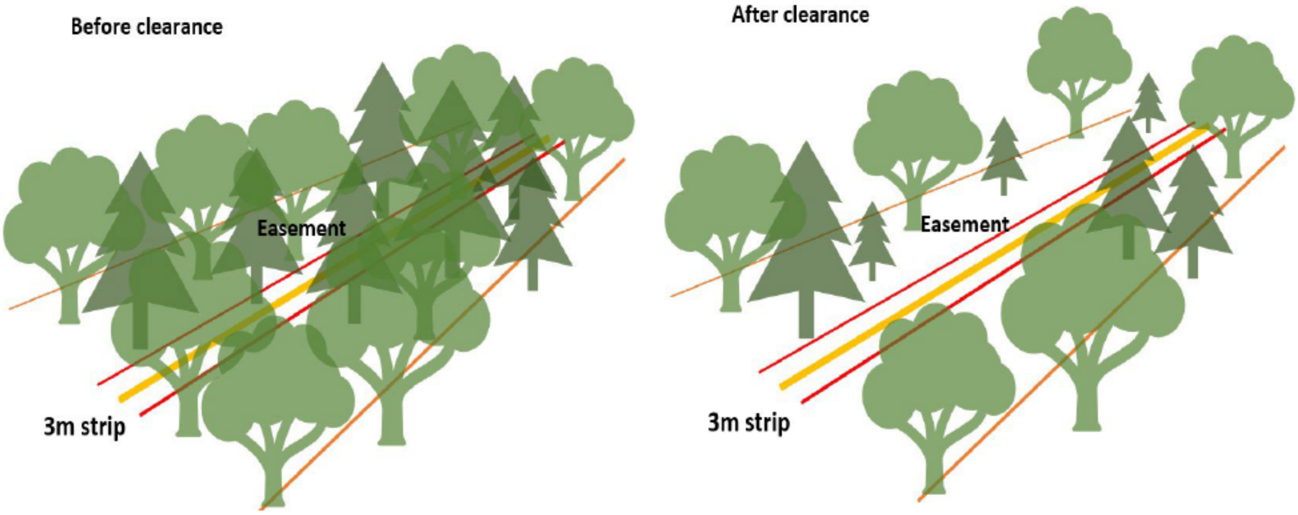


Figure 8: Desired outcome from this proposed programme of vegetation clearance investments

6.6.4 Controlled felling and heavy machinery is required however no outage or pressure reduction is required to carry out this intervention.

Easement Reinstatement Campaign (Scrub Clearance)

6.6.5 This option involves removing scrub less than 4m high within the 3m strip (1.5m either side of a pipeline). This is indicated by the area between the two red lines in Figure 8.

6.6.6 This will be undertaken where clearance can be conducted manually or with hand tools such as hand chainsaws and towing a woodchipper behind a 4x4 vehicle.

6.6.7 No outage or pressure reduction is required to carry out this intervention.

Intervention Summary

6.6.8 The below table shows a summary of the above interventions.

Table 18: Interventions considered for vegetation clearance

Intervention	Equipment Design Life	Positives	Negatives	Taken Forward
Counterfactual (Do Nothing)	N/A	There is no CAPEX investment required.	Does not resolve overgrowth issue. NGT fails to fulfil HSE's Action Legal and legislation compliance.	No
Easement Reinstatement Campaign (Tree Clearance)	N/A	Removes unwanted mature trees within close proximity of the pipeline assets reduces risk posed by vegetation and subsequent failure modes discussed in 6.5.	Highest CAPEX spend. Intervention alone does not fulfil HSE's Action Legal nor our compliance to legislation. Vegetation less than 4m remaining may pose challenges and dangers to maintenance activities and safety to personnel working close to the pipeline and the public.	Yes

Easement Reinstatement Campaign (Scrub Clearance)	N/A	Removes unwanted low-density vegetation within close proximity of the pipeline assets reduces risk posed by vegetation and subsequent failure modes discussed in 6.5. Smaller CAPEX investment is required compared to clearing trees over 4m.	Intervention alone does not fulfil HSE's Action Legal nor our compliance to legislation. Vegetation over 4m remaining may pose challenges and dangers to maintenance activities and safety to personnel working close to the pipeline and the public.	Yes

Volume Derivation

6.6.9 Development of bottom-up volumes of vegetation overgrowth interventions for RIIO-GT3 is summarised in the table below.

Table 19: Volume derivation of interventions considered for vegetation overgrowth

Intervention	Volume	Unit of Measure	How this volume has been developed
Easement Reinstatement Campaign (Tree Clearance)	184.543	Per km	[redacted]
Easement Reinstatement Campaign (Scrub Clearance)	253.262	Per km	[redacted]

Unit Cost Derivation

6.6.10 A summary of the unit costs for these interventions is provided in Table 20. Further breakdown of costs for the interventions is provided in Appendix 2.

Table 20: Intervention Unit Cost Summary Table (£m, 2023/24)

Intervention	Unit of Measure	Unit Cost	Cost Accuracy	Number of Data Points	Source Data
Easement Reinstatement Campaign (Tree Clearance)	Per km	[redacted]	+/-10	1	Estimate at Cost of Completion
Easement Reinstatement Campaign (Scrub Clearance)	Per km	[redacted]	+/-10	1	Estimate at Cost of Completion

6.6.11 We provided the intervention scopes to [redacted] who is our contractor responsible for current scrub clearance for unit cost quotations. These were then built up by first principles estimation to calculate the estimate project costs including NGT overheads and risks.

7 Options Considered

7.1 Portfolio Approach

7.1.1 In developing our plans and making our decision we have been cognisant of the need to develop plans that are value for money and deliverable, whilst achieving a suitable level of risk of our aging assets. In considering the most effective combination of interventions, we have challenged whether our preferred programme of investments is the most cost-beneficial by carrying out a full Cost Benefit Analysis (CBA) utilising our Copperleaf Portfolio Optimisation tool.

7.1.2 In line with HM Treasury Green Book advice and Ofgem guidance we have appraised whether investment in Pipeline Cathodic Protection across the RIIO-GT3 period is value for money by assessing the benefit over a 20-year period in the CBA.

7.1.3 Whilst this EJP has focused on our investment addressing pipeline integrity, our business case has been assessed across our entire pipeline portfolio. We have assessed a variety of investment portfolio options across the pipeline portfolio, to meet the investment drivers defined within the problem statement, business plan commitments and consumer priorities.

7.1.4 We have utilised engineering assessment as described in the previous chapters to derive intervention volumes. Each investment has been assessed using the Ofgem-approved NARMs Methodology, which is embedded within Copperleaf, which calculates both the monetised risk reduction and the Long-Term Risk Benefit (LTRB).

7.1.5 By using the NARMs Methodology, we can quantify the impacts of each investment across Service Risk Measures, all of which are reported in the NARMs Business Plan Data Table.

7.1.6 Under the current process for NARMs, only one intervention is assessed per asset. Therefore, a single CBA has been done for pipelines which covers both this EJP and NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

7.1.7 Of all the interventions proposed on our pipeline, the benefit of some cannot be modelled (e.g., replacement of Pipeline Insulation Joint). From the interventions where it is possible to model a benefit, a choice had to be made of which to represent in the CBA. This has resulted in the selection of one portfolio option across the pipeline portfolio, to meet the investment drivers defined within the problem statement, business plan commitments and consumer priorities.

7.1.8 This portfolio option presents the minimum work required to achieve compliance with legislation.

7.1.9 Another challenge for the CBA is that although we have ~640k of pipelines assets (each representing a 12m section of pipeline), each carries a relatively small amount of individual risk. In modelling terms, a dig following an ILI would have a small benefit for the section it was carried out upon compared to doing nothing. This benefit is negligible however when compared against the benefit of replacing a CP system which benefits hundreds to thousands of sections. We are only able to model the benefits as a pipeline portfolio of work using CP replacement as the modelled intervention in the CBA for our pipeline asset.

7.1.10 Intervention benefits are valued based on changing the input parameters of these calculations to determine the benefit to individual pipelines of different types of interventions. For instance, a CIPs dig would decrease a metal loss defect size and increase the cathodic protection experienced by a pipeline against the do nothing position.

7.1.11 A table summarising pipeline interventions considered in this EJP and NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3 which have parameters in the model that can be varied to correspond to benefits can be found in Appendix 4.

7.2 Options

7.2.1 Due to the process of NARMs methodology used to assess benefits of each intervention on our assets, we are only able to assess the benefits of carrying out CIPS Remediation interventions via CP replacement in our analysis. This approach is documented in section 9.1.

7.2.2 Pipeline assets are modelled in 12 metre sections with a risk value and asset intervention option applied to its respective 12 metre section. A limitation of our pipelines model is that we are unable to assess multiple interventions per section. With ~640k pipeline assets in our decision support software, viewing the results of multiple intervention options at 12 metre sections provides 6.4 million potential solutions. The most cost beneficial interventions to achieve legislative compliance has been chosen at an asset level and the results presented at a portfolio level.

7.2.3 As a result of the above, we are unable to evaluate multiple portfolio options in line with other Asset Health EJPs and have taken the decision to present a portfolio view across Pipelines.

Option 1: Total Monetised Risk Stable to RIIO-T2 Start

7.2.4 In this option we have constrained the overall level of NARMs risk at the end of the RIIO-GT3 period to remain consistent with the levels of risk at the start of the RIIO-T2 period. Individual NARMs service risk measures are not individually constrained, however overall risk outcome is. We have modelled the costs and benefits of carrying out CP replacements proposed in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3 as that is the only intervention with variable parameters that are adjustable to reflect benefits.

7.2.5 The total spend of proposed interventions in this option is £146.69m (2023/24) which includes the options presented in this EJP and NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3. All investments making up the £146.69m portfolio option are shown in Table 23 below.

7.2.6 This option maintains compliance with legislation and achieves stable risk. No additional investment is proposed through our Predictive analytics model.

7.2.7 The proposed intervention volumes and the associated spend for this option that can be modelled are shown in Table 21 below which the CBA analysis is based on. We are unable to model the other interventions which make up this portfolio of works, so they have not been included within the below table.

Table 21: Option 1 Summary (£m, 2023/24)

Intervention	Volume	RIIO-GT3 Value
CIPS for Capital Refurbishment	5,324 km	[redacted]

Option 1A: Post deliverability

7.2.8 This option has not changed from the above option 1 following completion of the deliverability assessment. This is largely due to the availability of pipeline outages setting the basis of the programme for the RIIO-GT3 portfolio of works.

Alternative options

7.2.9 Risk scenarios such as + or - 10% risk levels provided in other Asset Health EJPs is not applicable in Pipelines portfolio due to limitations described in section 9.1. This is consistent with how we presented our pipeline portfolio investments in RIIO-T2.

7.3 Options Summary

7.3.1 The below presents the technical summary table for the portfolio option presented.

Table 22: Options Technical Summary Table (£m, 2023/24)

Option	First Year of Spend	Final Year of Spend	Total Volume of Interventions	Investment Design Life	% of Assets Intervened On	Total Spend Request
Counterfactual (Do Nothing)	N/A	N/A	0	N/A	[redacted]	[redacted]
Total Monetised Risk Stable to RIIO-T2 Start	FY27	FY31	5,324km	40 years	[redacted]	[redacted]

7.3.2 The options presented within this portfolio of works are shown in the below table. The highlighted green shows the intervention options which make up this EJP. The CBA is modelled using the spend request which comprises of the below.

Table 23: Portfolio intervention breakdown

Intervention	First Year of Spend	Final Year of Spend	Volume	Investment Design Life	Total Spend re [redacted] 2023/24)
In Line Inspection (Pipeline PSSR Inspection)	FY27	FY31	72	40 years	[redacted]
In Line inspection Defect Digs	FY27	FY31	160	40 years	[redacted]
OLI/4 (Pipeline PSSR Inspection)	FY27	FY31	35	40 years	[redacted]
OLI/4 Pipeline Defect Remediation	FY27	FY31	23	40 years	[redacted]
CIPS for Capital Refurbishment	FY27	FY31	5324km	10 years	[redacted]
CIPS Remediation - CIPS Dig	FY27	FY31	159	40 years	[redacted]
Replace Insulation joint- Pipeline to Pipeline	FY27	FY31	0	40 years	[redacted]
Replace existing Transformer/Rectifier	FY27	FY31	130	40 years	[redacted]
Repair/replace existing CP Test posts	FY27	FY31	1450	40 years	[redacted]
Easement Reinstatement Campaign (Scrub Clearance)	FY27	FY31	253	40 years	[redacted]
CIPS Remediation - Install new CP system/system Item	FY27	FY31	44	40 years	[redacted]
Legacy Flow Stop Device Investigation	FY27	FY31	5	40 years	[redacted]
Legacy Flow Stop Device Remediation	FY27	FY31	2	40 years	[redacted]
Easement Reinstatement Campaign (Tree Clearance)	FY27	FY31	185	40 years	[redacted]
Bacton Road Crossing- Integrity Inspection	FY28	FY30	1	40 years	[redacted]
Total					**146.69**

8 Business Case Outline and Discussion

8.1 Key Business Case Drivers Description

8.1.1 All the options presented are driven by safety legislation, asset health deterioration, HSE Action Legal along with prevention of external interference.

8.1.2 We have considered the impact of the following drivers for investment:

- Continued compliance with legislation to ensure that we adequately inspect our pipeline and validate their safe continued usage.
- Protect members of the public and the environment from a loss of containment event.
- Protect long-term integrity of our pipeline assets to ensure a continued supply of service.
- Increased knowledge of the asset health condition of buried bolted fittings which may present a risk to our ability to operate the network safely and to ensure we proactively address a potential loss of containment event.
- Compliance with the Action Legal from HSE in October 2023 by delivering a programme of works to clear the pipeline easement. This includes demonstrating an effective monitoring and review of the preventive and protective measures related to the easement.

8.2 Business Case Summary

8.2.1 Our investments proposed in this paper maintain statutory compliance whilst striking an appropriate balance between tolerable risk and value for money for consumers.

8.2.2 A Cost Benefit Analysis (CBA) has been undertaken to appraise our suggested investment activity using the NARMs methodology which confirms that the option of surveying and targeted remediation is the lowest cost option to maintain compliance. The CBA results are shown in The graph below shows the payback period if we carried out the CP replacement investment proposed in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

8.2.3 The graph below shows the payback period if we carried out the CP replacement investment proposed in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

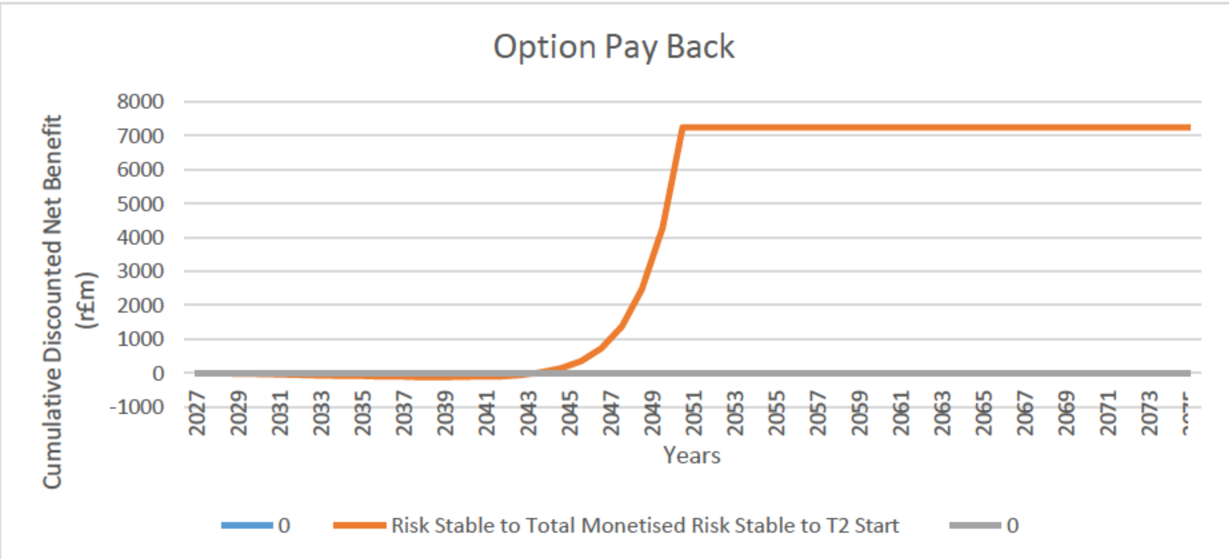


Figure 9: Option pay back graph for the proposed CP replacement intervention.

8.2.4 As shown in the graph, this programme of investments will pay back in 2044.

Table 24: Business case metrics of options (£, 2023/24)

Option	Total Volume of Interventions	Total Spend Request	Outcome Risk End of RIIO-GT3	% change in comparison to start of RIIO-T2	PV Costs	PV Benefits	NPV	CB Ratio	Payback Period from 2031	% change in service risk measures compared to start of RIIO–T2				
										Financial	Health and safety	Environmental	Availability Reliability	Societal
Option 1A: Risk Stable to RIIO-T2 Start	5,324km	146.69	56.94	116.7501%	25,403.61	25,341.61	25,341.61	409.69	9 years	101.26%	111.34%	119.68%	133.04%	115.75%

9 Preferred Option Scope and Project Plan

9.1 Preferred Intervention Options

9.1.1 The preferred option to manage our pipeline assets is Total Monetised Risk Stable to RIIO-T2 Start. Our programme of investment on pipelines has been taken through a deliverability assessment which assesses this programme of works against outputs across our entire capital investment plan. The preferred option is listed in Table 25 below.

9.1.2 Our proposed investment achieves compliance with legislation, validating our transmission pipelines for continued operation, whilst striking an appropriate balance between tolerable risk and value for money for consumers.

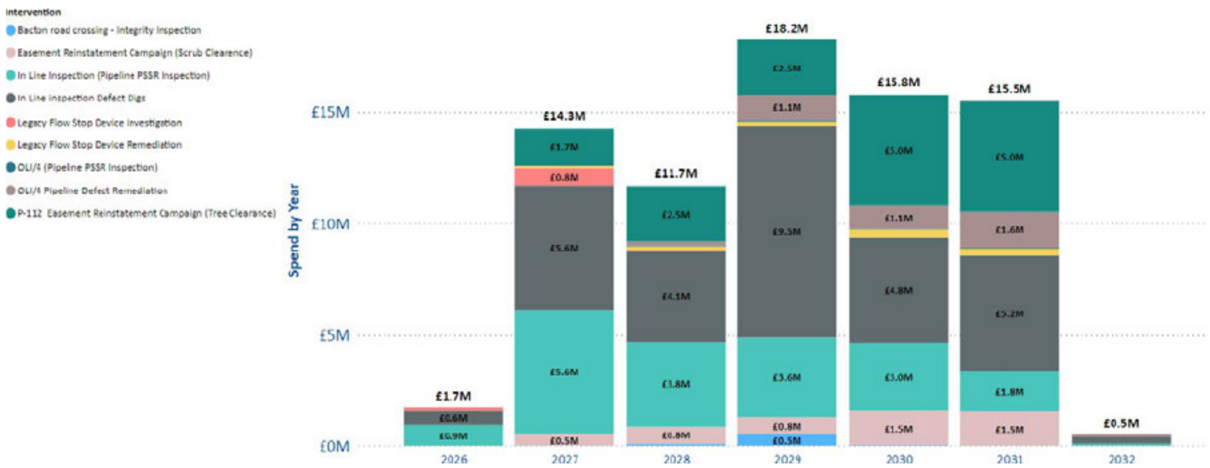
Table 25: Preferred option summary (£m, 2023/24)

Intervention	Primary Driver	Volume	Unit of Measure	% Assets Intervened Upon	Total RIIO-T3 Request	Funding Mechanism	PCD Measure
In Line Inspection (Pipeline PSSR Inspection)	AH Legislation	[redacted]	Per inspection	50%	18.99	Baseline	NARMS
In Line inspection Defect Digs	AH Legislation	[redacted]	Per project	50%	30.00	Baseline	NARMS
OLI/4 (Pipeline PSSR Inspection)	AH Legislation	[redacted]	Per inspection	40%	0.22	Baseline	NARMS
OLI/4 Pipeline Defect Remediation	AH Legislation	[redacted]	Per project	40%	4.09	Baseline	NARMS
Bacton Road Crossing Inspection	AH Legislation	[redacted]	Per inspection	100%	0.63	Baseline	NARMS
Legacy Flow Stopping Device-Investigation	AH Risk Management	[redacted]	Per asset	N/A	0.94	Baseline	NARMS
Legacy Flow Stopping Device-Remediation	AH Risk Management	[redacted]	Per asset	N/A	1.14	Baseline	NARMS
Easement Reinstatement Campaign (Tree Clearance)	AH Legislation	[redacted]	km	2%	16.53	Baseline	NARMS
Easement Reinstatement Campaign (Scrub Clearance)	AH Legislation	[redacted]	km	3%	5.13	Baseline	NARMS
	Total	289 + 437,805 km		50%	77.7		

9.1.3 Our costs and volumes have been built using a formalised methodology using outturn data for similar works or survey information. We therefore propose the investment within this EJP is funded via baseline funding and will be assessed using an Asset Health - NARMs PCD, and cost variance managed through the TIM mechanism.

9.2 Asset Health Spend Profile

9.2.1 The below spend profile provides an indicative view on when the above interventions are to be carried out.



[redacted]

9.3 Investment Risk Discussion

9.3.1 The investment risk in this EJP is considered low and as the drivers of this investment are legislation and HSE Action Legal we believe a lack of investment would not be acceptable.

9.3.2 There is risk of not being able to deliver the volume of work is small.

9.3.3 The ILI and OLI programme of inspections is well-established with scopes that are clearly defined and understood. We have a good track record for delivering these scopes in RIIO-GT2 with no change to these scopes proposed for RIIO-GT3.

9.3.4 The scopes of new interventions (i.e. legacy flow stopping device inspections and remediations, easement reinstatement campaign tree and scrub clearances) are also well defined and understood.

9.3.5 As inspections and remediations of legacy flow stopping device require feeder outages to excavate the assets, there is a risk of outage issues (prior, during or post mobilisation). This is mitigated by deliverability assessment and continuous monitoring of plan delivery.

9.3.6 Tree and scrub clearance interventions do not require outage; therefore, we are confident in delivering the works as planned.

9.3.7 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.

9.4 Project Plan

1.1.1 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 26: 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)

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

Table 27: Pipeline Portfolio Programme for RIIO-GT3 period

Sanction/Intervention	RIIO-T2		RIIO-GT3					
	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32
T3_Pipelines_Bacton Road Crossing								
T3_Pipelines_FY27								
T3_Pipelines_FY28								
T3_Pipelines_FY29								
T3_Pipelines_FY30								
T3_Pipelines_FY31								
T3_Pipelines_ILI Dig								
T3_Pipelines_OLI 4 Remediation								
T3_Pipelines_PSSR								
T3_Pipelines_River Crossings								
T3_Pipelines_Scrub Clearance								
T3_Redundant Assets Construction_Lot 2								

9.4.2 The work has been profiled based on a deliverability assessment across the whole NGT plan. The In-line inspection programme and availability of pipeline outages acts as fixed points which the remaining work profile is programmed around.

9.5 Key Business Risks and Opportunities

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

9.5.2 However, a transition to Hydrogen within the UK gas network may affect the pipeline inspections and defect remediation investments proposed in this EJP. If a decision is taken to repurpose existing pipelines, we may have to inspect some pipeline sections sooner than originally planned. A reduction in the number of pipelines available to transport methane will make facilitating future pipeline outages for maintenance activities increasingly difficult.

9.6 Outputs included in RIIO-GT2/GD2 Plans

9.6.1 All investments proposed in RIIO-T2 in this theme are currently on track to be delivered within RIIO-T2, or have been completed already, hence this RIIO-GT3 investment plan does not contain any re-inclusion of previously funded/proposed investments in RIIO-T2.

10 Appendices

10.1 Appendix 1 - Additional equipment and legislation information

10.1.1 The design, construction, operation and maintenance of the Pipeline is subject to both PSSR and PSR:

- **Pressure System Safety Regulations 2000 (PSSR)** – general legislation for all pressure vessels and defines the regime for setting inspection frequencies and subsequent remediation of defects.
- **The Pipeline Safety Regulations 1996 (PSR)** – specific legislation for those operating pipelines and places the obligation to manage the safety risks that they present to members of public and NG staff.

10.1.2 As a primary means of corrosion protection, barrier systems are applied to the outside surface of a pipeline to limit or prevent the metal substrate coming into contact with any harmful long-term effects of the environment and/or electrolyte that the pipe is immersed in or exposed to. Coating types used to protect pipelines have changed throughout the last 50 years, we therefore have various coating methods in use depending upon the location and age of the pipeline.

10.1.3 Cathodic Protection (CP) systems are installed along the length of our pipelines to provide a secondary line of defence where coating breakdowns exist. The key elements of the impressed current CP systems are the transformer rectifiers, ground beds, CP test post and remote monitors. Further information about CP systems is documented in NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3.

10.1.4 The majority of the NTS pipelines (>99%) have been designed and constructed to be internally inspectable with Pipeline Inspection Gauge (PIG) traps facilities to enable ILIs of below ground pipeline without the need for an outage of the pipeline. A regime of ILIs assures the integrity of the pipeline and identifies any necessary remediation to be targeted.

Flow Stopping Device

10.1.5 Hot tapping, or “pressure tapping”, is the method of making a connection to existing piping or pressure vessels whilst maintaining gas flow in that section of pipe or vessel. It allows safe and efficient interventions without shutting down the entire system by isolating flow in a section of the pipeline temporarily.

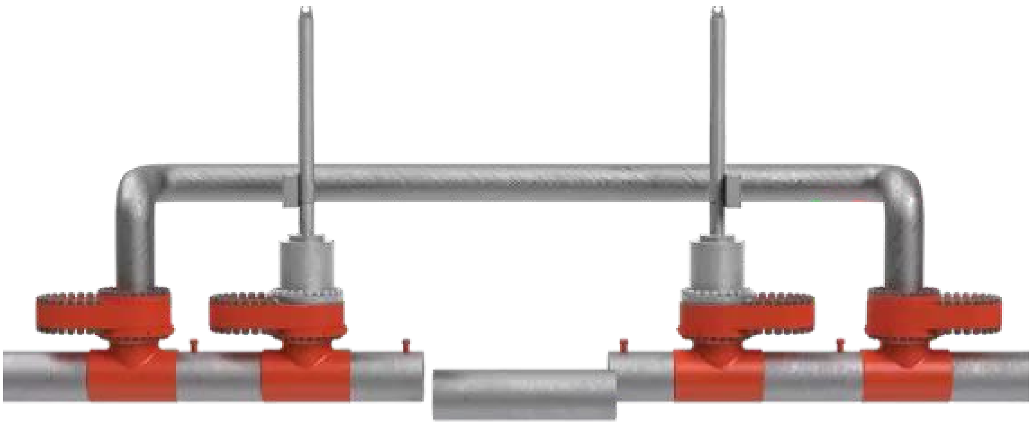


Figure 11: Pipeline ‘hot tap’ process to facilitate temporary isolation of a section.

10.1.6 A pipeline stopple, also known as a “line stopper” or “pipe stopper”, as shown in Figure 7, is a device fitted as part of the hot tap process. When the operation has been completed, the stopple is left in situ.

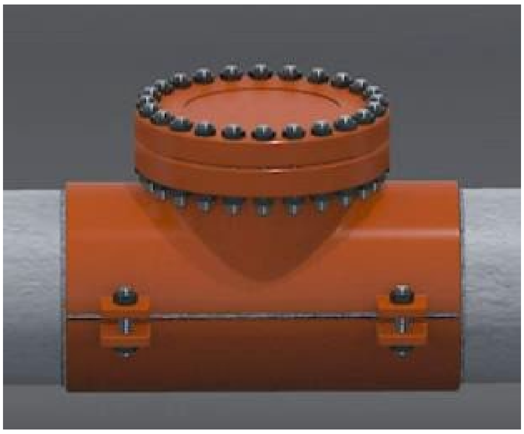


Figure 12: Stopple fitting (TD Williamson)

10.1.7 Pipeline stopples have a wide range of applications:

- **Maintenance and Repairs:** isolate damaged or malfunctioning sections of pipelines to carry out routine maintenance and repairs.
- **Inspections**: enable thorough inspections of pipeline integrity and the detection of potential issues like corrosion or leaks.
- **Emergency Response:** isolate the affected area in the event of a pipeline rupture or leak, minimizing environmental damage and safety risks.
- **Hot Tap**: for creating a connection to a live pipeline to enable works to take place without interrupting the operation of the pipeline.

10.2 Appendix 2 - Cost Breakdown

Intervention	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 Unit Cost
In Line Inspection (Pipeline PSSR Inspection)	[redacted]										
In Line inspection Defect Remediation											
OLI/4 (Pipeline PSSR Inspection)											
OLI/4 Pipeline Defect Remediation											
Bacton Road Crossing Inspection											
NEW Legacy Flow Stop Device Investigation											
NEW Legacy Flow Stop Device Remediation											
Easement Reinstatement Campaign (Tree Clearance)											
Easement Reinstatement Campaign (Scrub Clearance)											

10.3 Appendix 3 - Action Legal

Filename: Appendix 3 - GTHSE23_144_RoW_Actions_Legal 1

10.4 Appendix 4 - Parameters changed on Copperleaf for modelling pipeline interventions proposed in Pipeline EJP and Cathodic Protection Pipelines EJP

	Copperleaf Parameter Name					
Intervention	Number of Metal Loss Defects	Maximum Depth of a Metal Loss Defect	Depth of Pipe Burial	Number of Repair Casings	CIPs Off Potential	Number of Impact Protection Slabs
ILI Dig And Shell Installation				Set to 1		Set to 1
CIPS Dig and Repair					Set to -1250	
CP Replacement					Set to -1250	
ILI Dig And Repair	Set to 0	Set to 0				

10.5 [redacted]

[redacted]