RIIO-GD1 Business Plan 2013-2021

Part B6

Asset Strategy

This paper forms part of Wales & West Utilities Limited Regulatory Business Plan 2013 - 2021. Your attention is specifically drawn to the legal notice relating to the whole of the Business Plan, set out on the inside cover of The Executive Overview (Part A) of the Business Plan. This is applicable in full to this paper, as though set out in full here.

Except where stated to the contrary, all financial values within this paper are stated in 2009/10 prices, inclusive of 1% efficiency and prior to real price effects. This is in order that they match the figures used within the detail of the Business Plan Data Template.

This is a redacted copy. We do not indicate where material has been redacted.

Table of Contents

Appendices

1. Introduction

Wales & West Utilities' Business Plan is built upon delivering what stakeholders require[1] which is largely dependent on the performance of the gas assets, and reflected in a suite of outputs[2] that measure:-

- Safety in the context of risk to the public and to our employees.
- Reliability of the gas network.
- The impact of our assets on the environment.
- Customer satisfaction.

Delivering stakeholder expectations is complemented by a suite of legal obligations we need to meet. We have developed a new and innovative asset strategy that takes all of this into account to deliver a risk based approach across each of the asset groups and builds in;

- Asset Health – an illustration of where an asset is along it's life span, and critically, when it approaches the end of its life, illustrated by an unacceptable probability of failure.
- Probability of Failure resulting from poor "health".
- Consequence of Failure measured in terms of the outputs that affect stakeholders.

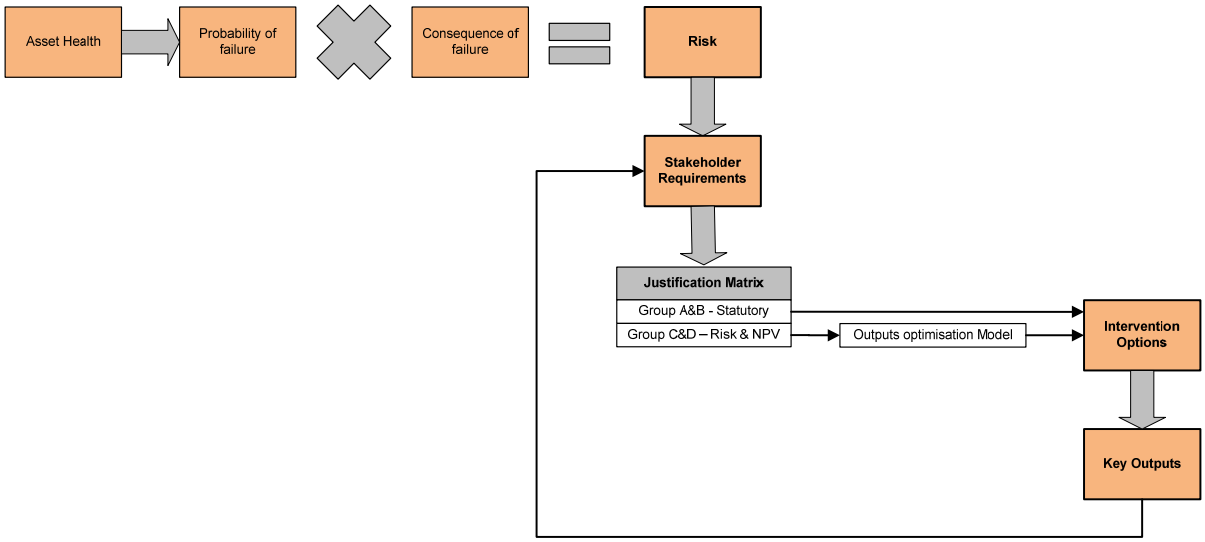
Our structured approach is designed to deliver value for money for current and future consumers by helping us to determine the right intervention on our assets at the right time to deliver the outputs stakeholders require; noting that expenditure and outputs are inextricably linked. This document describes the approach we have taken.

[1] See Part B5 - Stakeholder Engagement

[2] See Part B1 - Outputs

2. Executive Summary

Wales & West Utilities' Business Plan aims to maintain the current delivery of a safe and reliable gas supply in accordance with stakeholder expectations, whilst also satisfying our legal obligations. A key consideration has been how best to deliver these outputs at the least whole life cost and delivering value for money to consumers. Our response to this has been to develop a new and innovative risk based asset strategy. This is described in the following diagram and illustrated further in Appendix 1.



The innovative approach we have taken to developing our asset strategy is at the leading edge of the industry, built upon best practice principles established in the electricity industry and extended further to calculate risk rather than just health. We have been developing decision support tools which are based on actual survey data and analysis to help us in this process to deliver a well justified business plan. This supports our desire to deliver continuous improvement and it is good to see that Ofgem are positively encouraging such innovation as part of the way that outputs will be achieved.

Whilst the future energy mix is still unclear, our belief is that there is a strategic future for gas in the longer term and our approach ensures that investment is driven by safety and legal compliance whilst delivering the outputs valued by our stakeholders, hence minimising any potential for stranded assets.

The overall impact is that we will be spending more operating expenditure going forward to maintain and refurbish assets which presents the least whole life cost option. This also has the consequential benefit of avoiding stranding of any new capital assets which we could have been investing in as an alternative.

Our asset strategy is built on the assumption that we will not experience any overall growth in demand for gas. However, it responds to the localised increases in peak demand which we expect to experience.

Our basic principle to date has been to make the right decisions for stakeholders, which have included the replacement of many of the assets as they reached the end of their life. In addition to this, we have been seeking to deliver the lowest whole life cost solution, which has included exploring options such as refurbishment and increasingly adopting risk based management. We are pleased that this approach is supported by

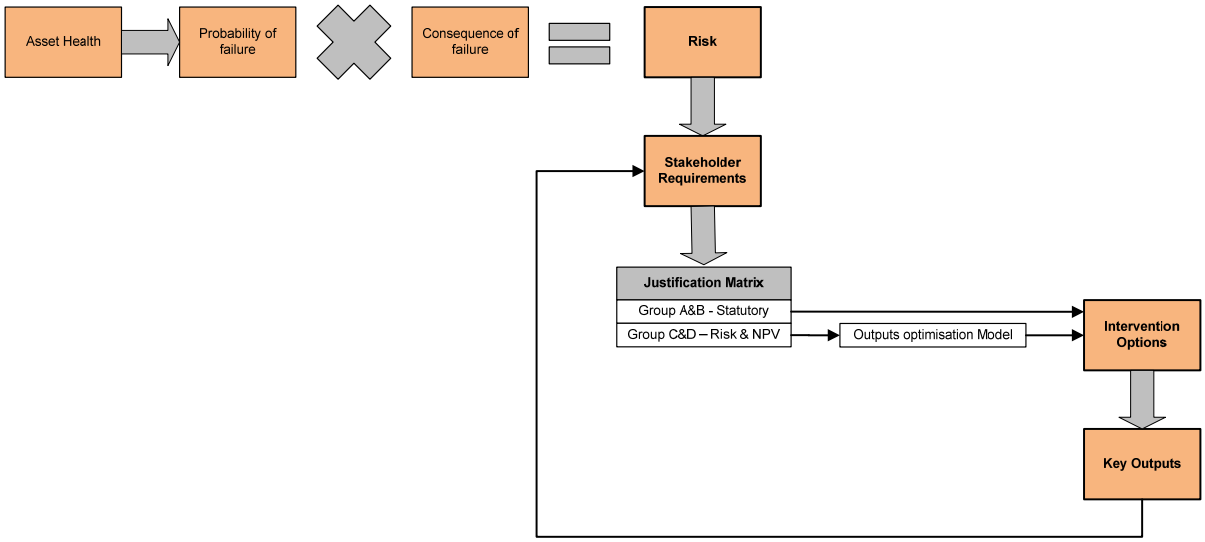
Ofgem under the RIIO principles where overall total costs and outputs are measured and incentivised.

3. Calculating Risk

3.1. Overview of WWU's Asset Strategy

On reviewing industry best practice, we began our journey by looking at the way that asset health is determined in the electricity industry which gave us a good foundation. We have since spent time developing an innovative model which builds in risk in order to help to target our intervention in the most appropriate areas.

The following diagram is designed to explain this systematic approach to understanding the health and risk of our assets to enable to us to define the appropriate intervention at the right time to ensure we deliver the outputs stakeholders require:-



This diagram is described in further detail in Appendix 1 which, for illustration purposes, also shows the various inputs in pictorial form.

3.2. Decision Support Tools

As part of our strategy we set out to develop a number of decision support tools. Our approach to this is specific to each asset group and is dependent upon the number and complexity of the assets themselves. The following table outlines the current risk models we have in place, or plan to develop:-

Asset Group	Risk Model	Model Timescale
National Transmission Offtakes	Condition Based Risk Management	In Place
Pressure Reduction Installations	Condition Based Risk Management	In Place
District Governors	Condition Based Risk Management	In Place
Above 7 bar pipelines	Condition Based Risk Management	Health Index in Place
Special Fittings, Supports & Crossings	Condition Based Risk Management	2013
Below 7 bar Mains	Mains Risk Prioritisation System Mains Risk Prioritisation Gas Full Mains Risk Assessment Model (inc consequence)	In Place In Place 2017
Low Pressure Gas Holders	Holder Decision Support Tool (Economic)	In Place
Above 7 bar Storage	Manual Assessment	In Place
Liquefied Petroleum Gas	Manual Decision Support Tool	In Place
Service Governors	Risk Matrix	2015
Services	Postcode analysis of service leakage	In Place

We are taking a balanced approach to the use of models, and acknowledge that it is not necessary to develop full Condition Based Risk Management Models for every asset group. As an example, the number of storage assets we possess does not warrant the use of a Condition Based Risk Management Model. However we have been using an alternative for some time, which is an economic model to enhance our decision making process.

For other asset groups such as low pressure service pipes, the development of a Condition Based Risk Management risk model would require the condition of the service population to be evaluated. Given that the pipes are buried, the way of assessing their condition would be to excavate to locate and examine the pipe. This is not practical for the large population of around 2.5 million service pipes. In its place, WWU is utilising condition and deterioration trends of the whole population combined with “post code” based leakage data to firstly assess appropriate levels of investments and secondly to determine where to target that investment.

In order to help to determine which metallic main to replace, we have been using a Mains Risk Prioritisation System for many years. This model deals with risk by building in the likelihood of an incident occurring. We are now embarking on an extension of this model to align it with our other risk models to incorporate consequence. We plan to work in co-operation with the other gas distribution networks and the Health & Safety

Executive to ensure that this is delivered by 2017. However our aspiration is to deliver it earlier.

3.3. The use of data

A key factor in the success of building, maintaining and improving decision support tools relates to managing and maintaining the data we have inherited and collected during surveys.

Prior to conducting any site survey, we have invested significant time in considering the factors that influence the model and the development of guidance to support classification during the survey. This included in-depth training with our operatives including gathering photographic evidence from the surveys. We have also taken time to audit the surveys for consistency with internal and external auditors.

Our initial efforts have focused on collecting actual data through specific site visits/surveys to collect data for the following asset groups:

- National Transmission System Offtakes.
- Pressure Regulating Installations (above 7bar).
- District Governors.
- Service Governors.
- Special Fittings Crossings & Supports.
- Liquefied Petroleum Gas Storage and Distribution Assets.

We plan that future data collection, where appropriate, will be integrated into our routine maintenance activities or will be gathered on a periodic basis depending on the asset group. A challenge going forward is to ensure that our core systems are developed to enable the capture of this additional required data, and we are currently developing an asset data strategy to account for this and other system improvements that we intend to make.

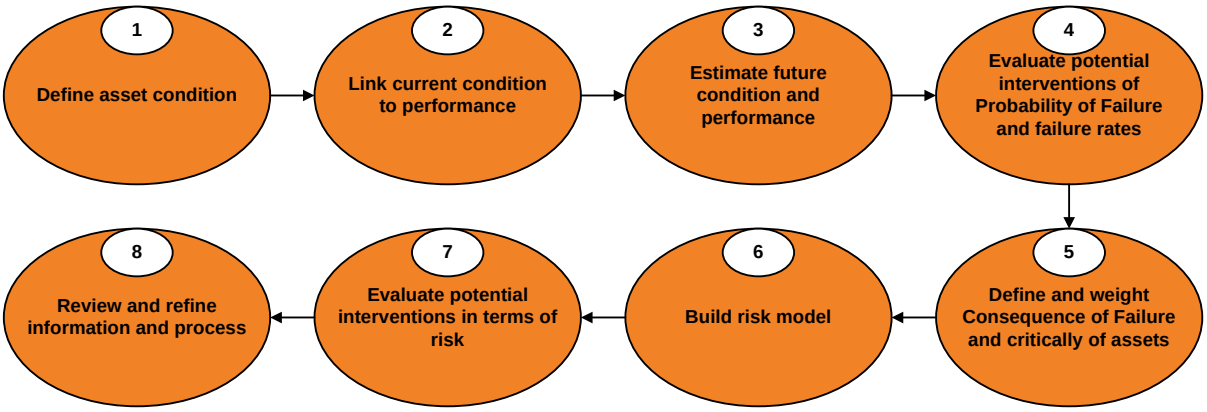
3.4. Development of Condition Based Risk Management (CBRM) models

As a concept, our desire was to move away from traditional, age based assessment of asset life, and to capture current and forecast future condition by a logical, numeric and “pan organisational” view.

In order to do this, we reviewed the best practice in the utility industry which led us to engage a specialist consultancy, EA Technology, with international expertise to help us produce our Condition Based Risk Management models. Our aspiration was to make the best possible decisions based upon all of the intelligence which led us to taking these models to a new level, building in consequence of failure and the optimum timing of interventions.

Condition Based Risk Management is a structured process that combines asset information, engineering knowledge and practical experience. The process defines current and forecasts future condition, performance and risk posed by the assets. This identifies and demonstrates the need for and benefit of replacement and/or refurbishment.

The following diagram outlines the key steps that we have undertaken during the development of our Condition Based Risk Management models:



3.5. Defining asset condition

To define and capture a single indicator that represents the overall condition of an asset, we have utilised a term of "Health Index". This is a representation of where an asset is along its useful life from commissioning through to the end of its life, where its likely performance would not meet stakeholder expectations. The "Health Index" is a proxy for the life of an asset, but the factors are significantly more complex than its age.

To determine the health index we considered multiple factors such as:

- The visual condition.
- The environment in which the asset operates.
- The duty that the asset is exposed to.
- The expected asset life, drawn from our experience.
- The fault history.
- "Maintainability" issues, such as obsolescence.

This allows us to score the asset with a health index between 0 and 10.The following example is typical of the long life assets used in gas distribution.

Condition	Health Index	Remnant Life	Probability of Failure
Bad	10	At EOL (<5 years)	High
Poor		5 - 10 years	Medium
Fair		10 - 20 years	Low
Good	0	>20 years	Very low

Note: "EOL" = End of Life

The models are calibrated such that a health index of 7 indicates an asset is rapidly approaching the end of its serviceable life and therefore an intervention is required. A health index above 7 is an unacceptable level of health because it is beyond this point that serious deterioration occurs. This would indicate a significant increase in the probability of failure of that asset and the point beyond which further degradation will be more rapid.

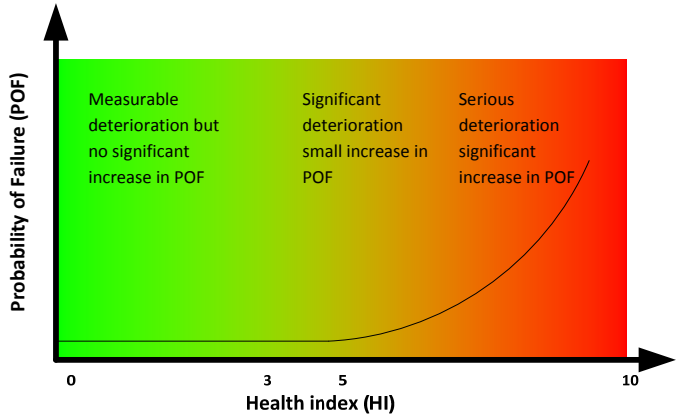
3.6. Ageing of assets

The "health index" profile is a 'snapshot' of the current condition. In order to forecast the condition, we predict how these assets will deteriorate. Based on our real life experience of assets the rate of deterioration is not linear, and accelerates as the assets move towards their end of life position.

In forecasting asset health, we are able to determine how future failure rates may be affected by different intervention strategies and this is supported by an algorithm that has been determined by utility industry research and validated by "learned" studies.

3.7. Probability of Failure

Knowing the "health index" of assets, whilst useful in being able to describe risk qualitatively, does not help us to determine risk without a quantifiable relationship with probability of failure (POF). The association has been determined by research into failures on similar assets. The "positioning" of the graph has been determined by actual WWU experience of failures on the type of asset in question.



3.8. Criticality

Historically, the industry models stopped at determining health and probability of failure. However our aspiration was to move these models to a new level so we could take decisions based on an understanding of the risk, which we believe needs to consider what the consequence of such a failure would be.

To start this part of the process we looked to define "criticality" which we use to describe the variation in consequence across a group of similar assets[3]. For example, on district governors, the number of consumers connected to each asset varies considerably, and

[3] Ofgem use the term "criticality" to indicate the consequence of failure of an asset

the impact on the down stream network of assets is determined by different configurations.

Criticality is therefore set in relationship with:

- Number and type of customers affected by a fault.
- Network configuration.
- Location of the asset.
- Pressure tier.
- Proximity of the asset to properties, i.e. the impact of disruptive failure or an explosion on buildings and occupiers.

These consequence factors are then weighted to represent the relative severity.

In order to estimate the relative significance of a failure, we establish the criticality of an individual asset for each consequence factor which is described below.

3.9. Consequence of failure

In defining the consequence of failure (COF), we took into account the outputs that stakeholders value as described in the following table:-

Category	Description	COF available scores
Safety	the value of loss of life or injury [4] (Fatality = £10m, Major Injury = £5m and a Minor Injury - £50,000)	1-5
Security of Supply	the cost to the consumer of being without gas [5]	1-3
Environmental	the cost to society of emissions from leaking gas[6]	1-3
Costs passed to the consumers	the cost of a failure for repair, restoration and compensation	1-5

We have considered in great depth how to value each of these areas in a way that is comparable across assets and asset groups, and have assigned a financial value to each area. This will help us in the future to compare the risk of assets across asset groups to understand the impact of our decisions on the outputs that stakeholders have asked us to deliver. These scores are added together to give a minimum available score of 4 and maximum available score of 16. This is explained further in Appendix 2.

[4] based on an independent report commissioned by WWU, from GL Noble-Denton.

[5] Domestic - The difference between retail price of gas and retail price of electric, as consumers would be forced to switch to electricity to power heating and cooking. Average Electric price £0.12 per kWh, average Gas price £0.03 per kWh, difference of £0.09 per kWh.

Industrial and commercial - The estimated loss of GDP from interrupted production and retail activities. Based on a report commissioned by the DTI, on the Economic Implications of a Gas Supply Interruption; which estimates a range of between £5.47 per Therm to £23.88 per Therm.

[6] Based on shadow cost of carbon - £66 per tonne (average over 8 year period from 2013 – 2021)

3.10. Calculation of risk

Our aspiration to move away from pure health and probability of failure by understanding the consequence of such failure enables us to calculate the current and future risk of each asset. Using all of this analysis we determine the risk by:

Risk = probability of failure x consequence of failure x criticality of the asset.

Examples of the outcome of this work can be found in each of the attached appendices.

3.11. Definitions & Scoring

As part of the requirement to complete Business Plan Data Template we have matched our scoring mechanism to that provided by Ofgem. Further explanation is contained in Appendix 2.

3.12. Timing of interventions

Once risk is defined in financial terms, it is possible to determine the most appropriate timing of the intervention which is calculated to mitigate that risk by combining the cost of the intervention, and the cost of risk into a single net present value calculation for each asset. We have used this feature to build the phasing of interventions in our Plan.

4. Stakeholder Views

We have a number of stakeholders who we engage with on a regular basis, e.g. the Health & Safety Executive. Our stakeholder engagement programme is designed to reach consumer groups and other stakeholders who can provide valuable feedback and validate our priorities, particularly in relation to our asset strategy.[7] Their views are summarised below.

4.1. Safety

- Delivering the mains replacement programme was considered a high priority.
- Maintaining the length of the 30 year replacement programme was widely supported.
- Some stakeholders felt that this programme should be accelerated because of the environmental and safety benefits although others were of the opinion that this may lead to an increase in disruption.
- Current level and standards of emergency response were good and appropriate but should not be allowed to slip.
- The proposals for the removal of gas holders were considered a lower priority by stakeholders as a whole. However this a safety priority for the HSE and those living in the vicinity.
- The HSE's feedback has been positive in terms of the direction WWU are taking and particularly support the removal of risk in accordance with our obligations utilising innovative Condition Based Risk Management (CBRM) Models. However, they have been cautious with their support for a methodology which can encourage the trading of risk between different asset groups and hence the population affected by them.

4.2. Reliability

- With regard to interruptions, many felt that the current level of service was good and that improving this was not a high priority.
- There was broad agreement that the service provided by WWU was sufficiently reliable at present and that maintaining the current high standards, rather than seeking to improve them, should form part of WWU's ongoing strategy.
- WWU's investment strategy for its asset replacement programme, resulting in reduced future expenditure, was commended, although it was felt that this should be reviewed at regular intervals.
- The HSE's feedback has been positive in terms of the direction WWU are taking utilising innovative Condition Based Risk Management (CBRM) Models which determine the Health Index and Risk Metric of assets. However, they have been cautious with the support of for a methodology which could see investment being diverted from safety into other benefits, such as customer interruption levels. They do, however, understand that a more holistic based approach can be useful,

[7] Part B5 – Stakeholder Engagement

but with the proviso of still requiring compliance with legislation, such as The Pipelines Safety Regulations.

4.3. Environment

- Reducing leakage was considered a top priority and there was general consensus that this should be WWU's main environmental focus.
- There was no support for an increase to consumer bills to fund environmental initiatives, such as the reduction in energy use by the business.
- It was widely agreed that increasing the proportion of gas from renewable sources should be a priority and should be encouraged.
- It was not felt that the cost of connecting renewable sources should be passed on to WWU.

5. Justification

5.1. Introduction to Intervention Groups

We have used four intervention groups to typify the drivers for intervention; Groups A, B, C and D:

- The justification for intervention is firstly the need to meet our statutory obligations, particularly with reference to the Pipeline Safety Regulations which state that "***The operator shall ensure that a pipeline***[8] ***is maintained in an efficient state, in efficient working order and in good repair.*** Compliance with legislation is the driver for our intervention groups A and B as shown below.
- The third intervention group C, is our response to stakeholder requirements, for example, to maintain reliability or serviceability of a group of assets.
- The fourth is where we have calculated that stakeholder value (financial) is derived by an intervention.

Opportunities for "trading" risk across asset groups to give the best result only exists in Groups C and D – we have no option on groups A and B, because this would be in breach of legislation.

Group	Tool	Driver
A	End of Life[9] in 2013/14	Legal compliance
B	End of Life by 2020/21	Maintain legal compliance
C	Maintain risk & hence consequence to stakeholders	Delivery of stakeholder required outputs
D	Net Present Value using Cost Benefit Analysis	Risk trading opportunities to deliver best value outputs

5.2. Groups A & B - Intervention to ensure legal compliance

Compliance with legislation is a key stakeholder required output. The majority of the intervention proposed throughout our business plan is associated with achieving such compliance and we have defined this as Group A and B.

Translating this to Asset Health; once an asset reaches a Health Index of 7 (Health Index of 5 in Ofgem's definitions) it is at the end of its serviceable life and therefore an intervention is required. This is the point of life where its condition related probability of failure increases exponentially and becomes unacceptable.

5.3. Group C - Intervention to deliver other stakeholder outputs

Once legal obligations have been met, we then consider the delivery of other outputs required by stakeholders. A good example of this is where stakeholders have told us that they want us to maintain reliability. We have a number of district governors which feed

[8] A pipeline is defined as any gas carrying component, including pressure regulating equipment and services, up to and including the Emergency Control Valve

[9] End Of Life is indicated by a Health Index greater than 7

more than 20,000 customers, and if one were to fail we would have the potential to lose the gas supply to all of those customers. In order to prevent this from occurring, and to maintain existing levels of reliability as required by stakeholders, we are planning to invest in new governors to reduce the consequence of failure. Note that in this group of intervention, it may be appropriate to improve the health index, reduce the consequence of failure or both.

In this intervention group it is possible to consider the impact of interventions across asset groups, either to achieve a target relating to aggregated risk within an asset group or across the whole network of assets.

5.4. Group D - Intervention to deliver best value to consumers

The delivery of best value through the use of financial models will be utilised to inform the timing of intervention, and to compare different investments across asset groups. This is where the condition may not yet be deemed unacceptable, but if we were to intervene prior to this we could defer the need for full replacement hence prolonging the life of the asset and providing a better value option for consumers.

5.5. Outputs Optimisation

Our intervention and subsequent expenditure are directly linked to the outputs we plan to deliver. In deciding between expenditure options within Groups C and D, we have also considered the impact on the various outputs that we deliver. The models developed aid our understanding of the impact of differing levels of intervention on each of the outputs, so that in undertaking trading across asset groups in Groups C & D, we have optimised the outputs delivered and hence the value delivered to stakeholders. This is particularly so for gas consumers, who fund the operation of the gas transportation system and rely on it to provide an acceptable level of robustness.

6. Intervention Options

In delivering best value for consumers we plan to deliver the outputs they require at the least whole life cost. Using a structured approach to understanding the health and risk of our assets helps us to understand what intervention is required, and the optimum timing to achieve this.

6.1. Interventions to restore asset performance

Since formation WWU has worked to ensure that its investment decisions have been for the benefit of stakeholders. In making those decisions we have considered the whole life cost of the various options available, and decisions have been made bearing these in mind together with safety, reliability and other factors in mind. Those options have included operating cost options in the form of maintenance type solutions, as well as the more traditional capital replacement approach.

In delivering optimum value we identify the "opex and capex tradeoffs" as part of our whole life cost analysis, and our more sophisticated asset management approach ensures that we look at this both ways. If there is an opportunity to spend operating expenditure which avoids capital expenditure and continues to deliver outputs, then this option is chosen if it demonstrates the best longer term value. Conversely, if there is an option where capital expenditure enables a reduction in operating expenditure which provides a better whole life cost then this will be the option taken.

We are pleased to see that, with the advent of RIIO-GD1, Ofgem has recognised this trade off between Opex and Capex and has embraced a Totex approach to management of the gas distribution infrastructure.

The approach we have taken is aimed at helping us to better determine the impact of the alternative interventions to wholesale replacement of an asset. This approach is wholly aligned to the totex regime. As such, we have defined seven different types of interventions which could apply to any asset group. These are described here:

Interventions to restore asset performance	
Classification	**Examples**
Type 1 – Full replacement Where an asset is at the end of its serviceable life, due to condition or obsolescence, and its original performance can only be restored by full replacement.	• Full replacement of an asset in situ or at an alternative location
Type 2 – Refurbishment Where an asset is either nearing the end of its life or is showing, or is beginning to show, signs of deteriorating condition and performance which is proactively restored by refurbishing it in whole or in part to extend its life.	• Reconditioning a Pressure Regulating Installation or District Governor • Targeting short length diversions of pipelines following integrity studies or enhancing Cathodic Protection • Pressure Regulating Installation component replacement such as pipe supports or actuators

Type 3 – Enhanced condition monitoring and risk management – where the condition of an asset is monitored closely through more frequent and/or more invasive inspection prior to making any decisions about refurbishing or replacing. This could also include managing risk until a permanent repair has been undertaken.	• Increasing the frequency / thoroughness of a pipeline inspection • New surveys of ductile iron mains • Management of a fault until permanently repaired
Type 4 – Non-routine reactive fault response – where a fault or failure necessitates an unplanned substantial reactive repair, typically high unit cost or low volume, this would also include unplanned refurbishment.	• Roof repairs on Pressure Regulating Installations or District Governors • Low Pressure Gas Holder cup seal repairs • Pipeline coating defect repairs (Close Interval Potential Survey remedial works) • Tree surgery
Type 5 – Non-routine proactive inspection and maintenance - **exceptional items** – typically infrequent (>5 years), high unit cost, or low volume planned maintenance activities which provide assurance of ongoing integrity.	• Internal inspection of pipelines by 'In Line Inspection' • 10 yearly wall thickness checks on gas holders • Intermediate and Medium Pressure Close Interval Potential surveys (10 yearly)
Type 6 – Routine proactive inspection and maintenance – typically frequent (<5 years), low unit cost, or high volume planned preventative maintenance activities.	• Valve maintenance on pipelines • Instrumentation calibration • Functional checks on District Governors • Inspection of service risers on multi-occupancy buildings
Type 7 – Routine reactive fault response – where we react to telemetry alarms, public or internally reported faults and undertake unplanned repairs.	• Responding to publicly reported escapes and repairing leaks • Responding to telemetry alarms on Pressure Regulating Installations • Responding to reports of low pressure • Replacing damaged pipeline marker posts

The decisions we take on which interventions we will deliver going forward will ensure an appropriate balance between the seven types of intervention in order to ensure we are compliant with our obligations, meet stakeholder expectations in terms of the outputs whilst also delivering the best value for consumers.

6.2. Network Approach to Investment

As part of our asset strategy we are taking a holistic view of our network which ensures that we undertake a suite of interventions in any given location which complement each other.

An example of this is an innovative approach to network management solutions which is designed to minimise pressure and therefore emissions from the pipe network. Historically efforts have focused on minimising pressure within the existing network configuration but we have taken this further by exploring opportunities to invest in the configuration to enable system pressures to be lowered significantly. These schemes are

referred to as Maximum Operating Pressure reduction projects and typically involve installation of new district governors and mains to allow the maximum operating pressure of a system to be reduced.

The cost of investment is evaluated against benefits of reduced carbon emissions and Public Reported Escapes. The schemes completed to date have a positive Net Present Value when considering only these factors, but a holistic approach to asset management has enabled significantly more benefit to be realised. This is achieved by:

- Ensuring new mains are laid in locations that maximise the opportunity to abandon parallel iron mains.
- Ensuring new governors are strategically placed, reducing criticality and therefore risk on existing district governors and also offering increased opportunity to utilise insertion techniques when replacing iron mains in the vicinity.

We will continue to look for opportunities to deliver this approach as a key part of our asset strategy.

7. Outputs & Next Steps

7.1. Outputs

The interventions and subsequent expenditure we make on our assets could affect any of the output categories that are described in Part B1 – Outputs. However there are three categories of major impact which are listed below, with a summary of the outputs targets we plan to deliver from 2013-2021:

Safety	Mains Replacement	Reducing the risk of an explosion in accordance with our programme
	Emergency Response	Continue to meet or exceed the 97% standard
	Repair	Maintaining average repair durations to stop gas following a leak, targeting high risk escapes first
	Major Accident Hazard Prevention	Compliance with our Safety Case

Reliability	Loss of gas supply	Maintaining level of asset health, risk and faults, and hence customer interruptions
	Network Capacity	Ensuring that the gas assets are capable of handling the required capacity in peak periods
	Records & Data Accuracy[10]	Maintain current performance for records

Environment	Business carbon footprint	Minimising emissions due to leakage
	Other emissions & resources	Minimising other emissions

The detailed outputs beneath these primary output headings can be found in Part B1 – Outputs, together with our current and projected performance against each of the specific primary and secondary outputs, as well as the way we plan to deliver them and the level of expenditure required to achieve the outputs.

As part of the price control review process, we have been heavily engaged with Ofgem in defining these outputs and we are pleased that the final output measures are those that we are already measuring and monitoring as part of our existing processes.

The emphasis on our asset strategy also enables us to report on our asset health and risk indices under the Reliability – Loss of Supply output category. We have been putting significant focus onto this output which has resulted in the completion of the Business Plan Data Template for 27 different Asset Groups as at

- 2010/11
- 2012/13
- 2016/17 and
- 2020/21

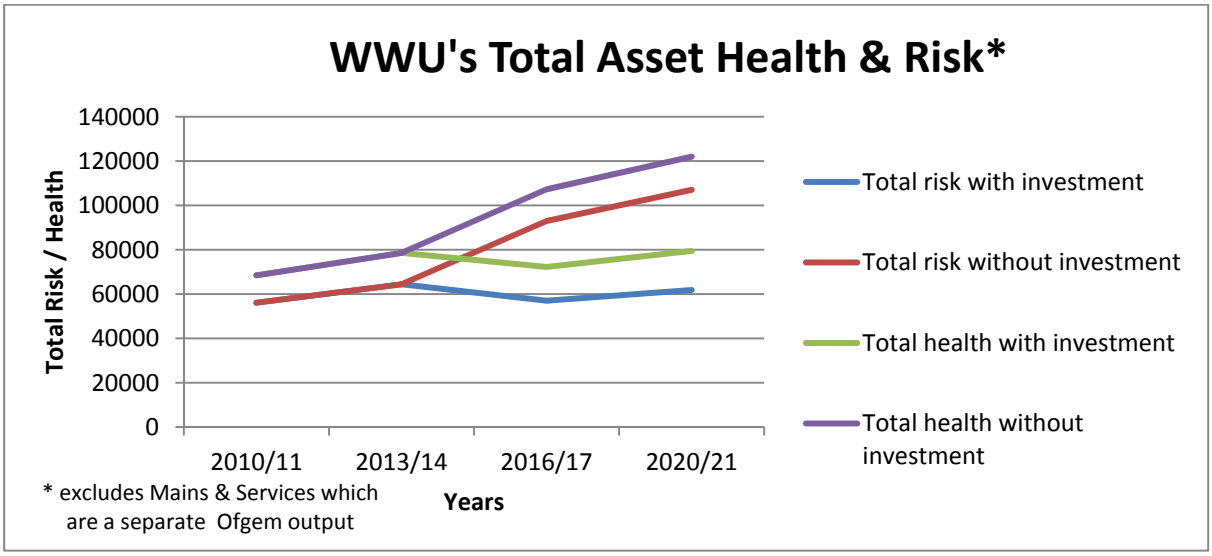
[10] Noting that this is no longer an Ofgem output. However WWU believe it is critical and still propose to measure and report against these measures

The basis of the strategy to manage our assets is to:-

- Ensure compliance with our legislative obligations.
- Deliver the outputs stakeholders require.
- Demonstrate value for money.

The aim of our business plan is to ensure we deliver the safety and reliability outputs our stakeholders require, based on the least whole life cost to them.

The following graph shows the total asset health and risk of WWU's assets; excluding mains and services which are reported separately in accordance with Ofgem's output.



As shown in the graph, the interventions proposed in our business plan are aimed at managing risk at broadly constant levels, whilst also managing deterioration by maintaining asset health. Subsequently there is very little impact to consumer bills.

Our Business Plan delivers:

- Legal compliance with The Pipelines Safety Regulations in a practical and innovative way.
- The safety and reliability outputs required by stakeholders, whilst managing an ageing network of assets.
- Environmental improvements which support a more sustainable future.
- Efficient delivery utilising an innovative approach to asset intervention.
- Investment that targets risk, not health (condition).
- Investment to support consumer and social obligations.

The Asset Health and Risk Index outputs are set out in each of the Appendices (2 to 28) attached to this Asset Strategy, with a brief description of how these have been calculated.

We are in the early stages of our development of this work and will be undertaking further development on the models whilst also generating more data to validate that our

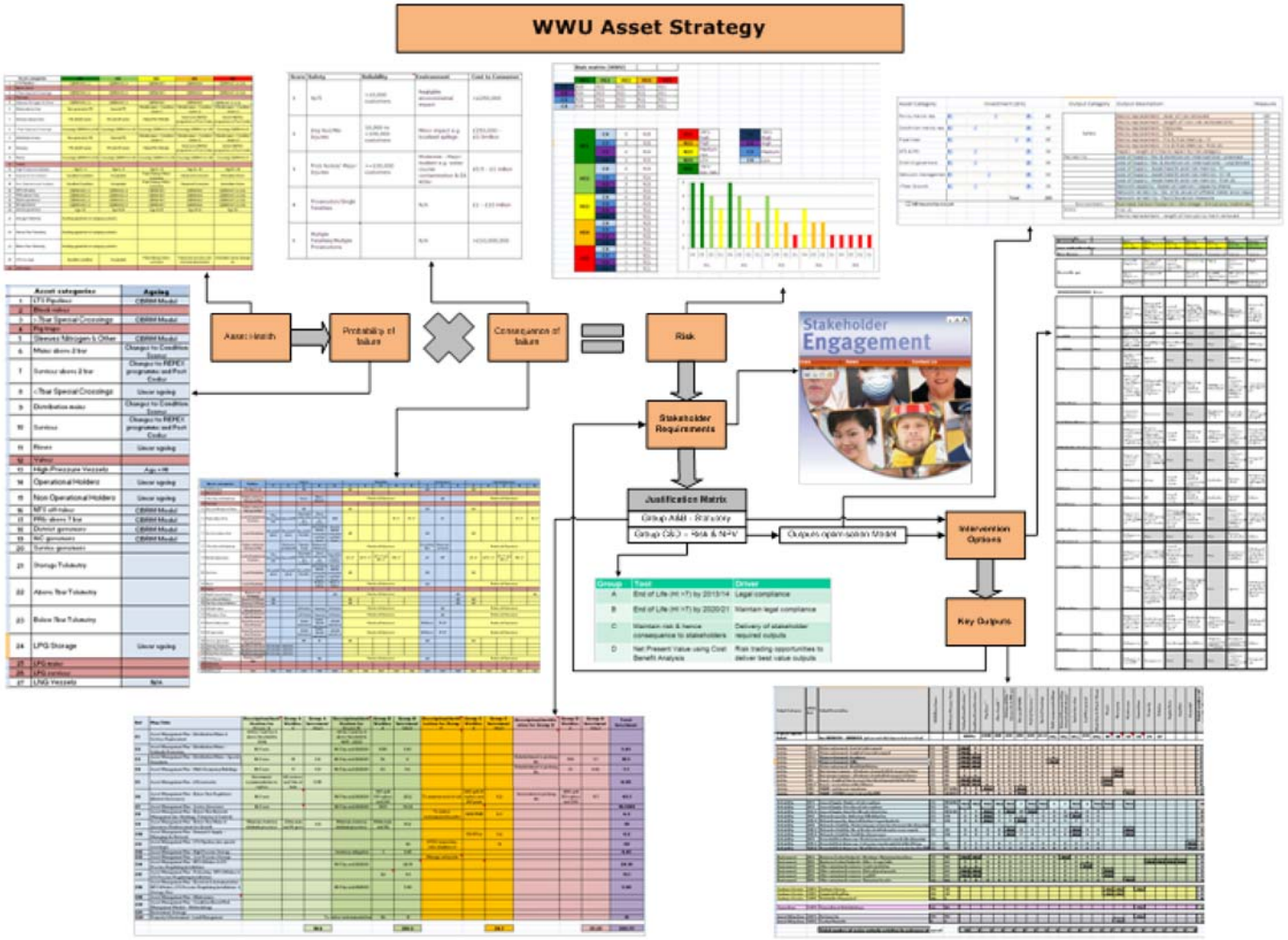
models are aligned to actual experience. We expect to learn significantly more about the performance of our assets, as well as the impact that the various types of interventions will have on the deterioration of these assets. This will in turn help to inform our ongoing asset strategy and the annual reporting requirement as part of a new licence condition, together with the requirement for us to explain our future asset strategy.

7.2. Next Steps

Significant effort has been placed on developing our asset strategy. However, we recognise that we are in the early stages of this process. As we move into RIIO-GD1 we will gather more data which will help us to further develop and validate our models. As our process matures we can also apply these lessons to other asset categories when considering the best approach for potential future models.

Our business plan is designed to provide a robust forecast of the workload required to meet stakeholder expectations, and will ensure that we modify our intervention plans in response to new and updated data and changes to stakeholder views. This will ensure we are delivering the outputs in the most cost effective way.

Appendix 1. Asset Strategy Diagram (for illustrative purposes only)



Appendix 2. Definitions and Scoring

As part of the Business Plan Data Template we are required to complete a number of tables in relation to asset health and risk as at 2010/11, 2012/13, 2017/18 and 2020/21.We have ensured our approach is consistent with Ofgem's descriptions as described below.

Health Index Scoring

Ofgem's health index scoring ranges from 1 to 5, but our scores range from 1 to 10 so have been mapped to the Ofgem categories as follows:-

Health	WWU HI	Description
HI1	0-1, 1-2, 2-3	New or as new
HI2	3-4, 4-5	Good or serviceable condition
HI3	5-6	Deterioration, requires assessment or monitoring
HI4	6-7	Material deterioration, intervention requires consideration
HI5	7-8, 8-9, 9-10, 10+	End of serviceable life, intervention required

Consequence of Failure Scoring

The following table shows how consequence of failure scores are derived. The scores against each category are added together to give a minimum available score of 4 and maximum available score of 16.

Score	Safety	Reliability	Environment	Cost to Consumer
1	Non Lost Time Injury	<10,000 customers	Negligible environmental impact	<£250,000
2	Improvement Notice / Minor Injuries	10,000 to <100,000 customers	Minor impact e.g. localised spillage	£250,000 - £0.5million
3	Prohibition Notice/ Major Injuries	>=100,000 customers	Moderate - Major incident e.g. water course contamination & EA letter.	£0.5 - £1 million
4	Prosecution/Single Fatalities	N/A	N/A	£1 - £10 million
5	Multiple Fatalities/Multiple Prosecutions	N/A	N/A	>£10 million

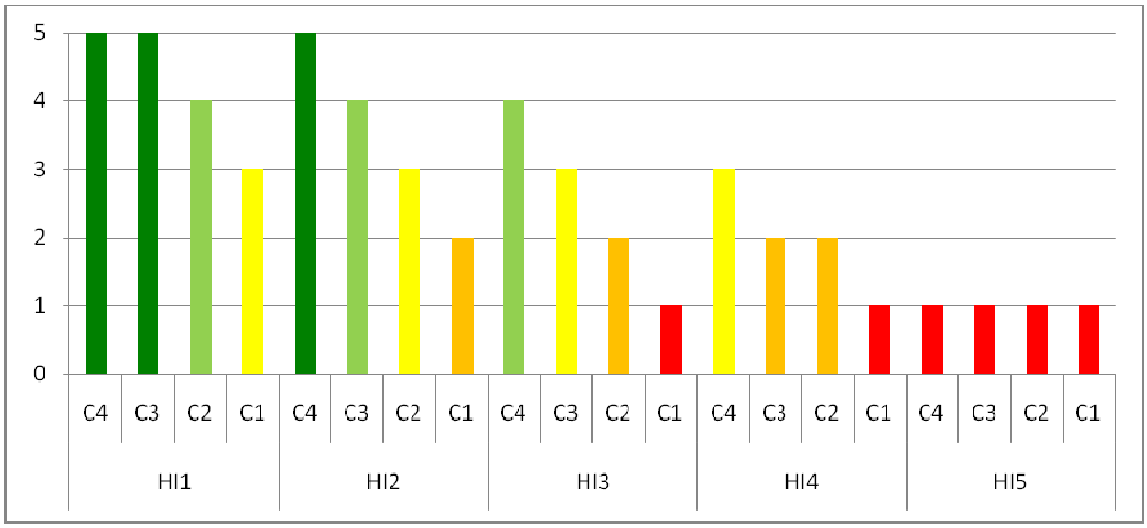
If any of the scores in the WWU categories reached a "5" then we have applied an override when adding up the scores to ensure this at least scored a C2 (High) in the Ofgem definitions. This is to avoid an instance where for example a score of 5 on Safety (multiple fatalities) ended up with just a medium criticality score.

The Ofgem criticality scores range from 1 to 5 and our consequence of failure scores range from 4 to 16.These scores have been mapped to the Ofgem categories as follows:-

Criticality	WWU COF	Description
C1	14, 15, 16	Very High
C2	11, 12, 13	High
C3	8,9,10	Medium
C4	4,5,6,7	Low

Risk Scoring

The risk score (on the y axis) is a product of the Asset Health and the Criticality as set out below. This indicates, intuitively, that the assets with the highest health index (approaching the end of their useful life), with the highest consequence of failure, present the highest risk. So an asset with a Health Index of 5, and a criticality of 1, presents very high risk:



A description of the Ofgem risk categories is shown below:-

Risk	
RI1	Very high risk
RI2	High risk
RI3	Medium risk
RI4	Low risk
RI5	Very low risk

Acronyms:-

HI = Asset Health C = Criticality COF = Consequence of Failure RI = Risk

Appendix 3. LTS Pipelines

Asset Population

WWU has circa 2400km of above 7 bar high pressure pipelines which transport gas between Offtakes and Pressure Regulation Installations which feed gas into the lower pressure systems. Line pipe is defined as the buried pipe within this system, i.e. excluding above ground sections / pipe bridges, which are categorised as above 7 bar special crossings. The population is not expected to grow, except via any new pipelines.

Health Index

During the summer of 2010 asset data including wall thickness, material grade, coating type, operating pressure, commissioning date, etc. for each pipeline section was gathered together. In addition condition data including the level of cathodic protection (CP) and fault history was attributed to this pipeline data. The combined data set was entered into a Condition Based Risk Management model that we had developed to produce a current Health Index in the range of 0.5 to 10 for each pipeline.

Ageing

The model has an ageing algorithm that forecasts the future Health Index of each pipeline in any given year. This algorithm has been produced in conjunction with an external asset management consultancy whose assumptions have been verified by university research.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, line pipes have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, and the Specified Minimum Yield Strength (SMYS) which would dictate the scale of release due to a failure.

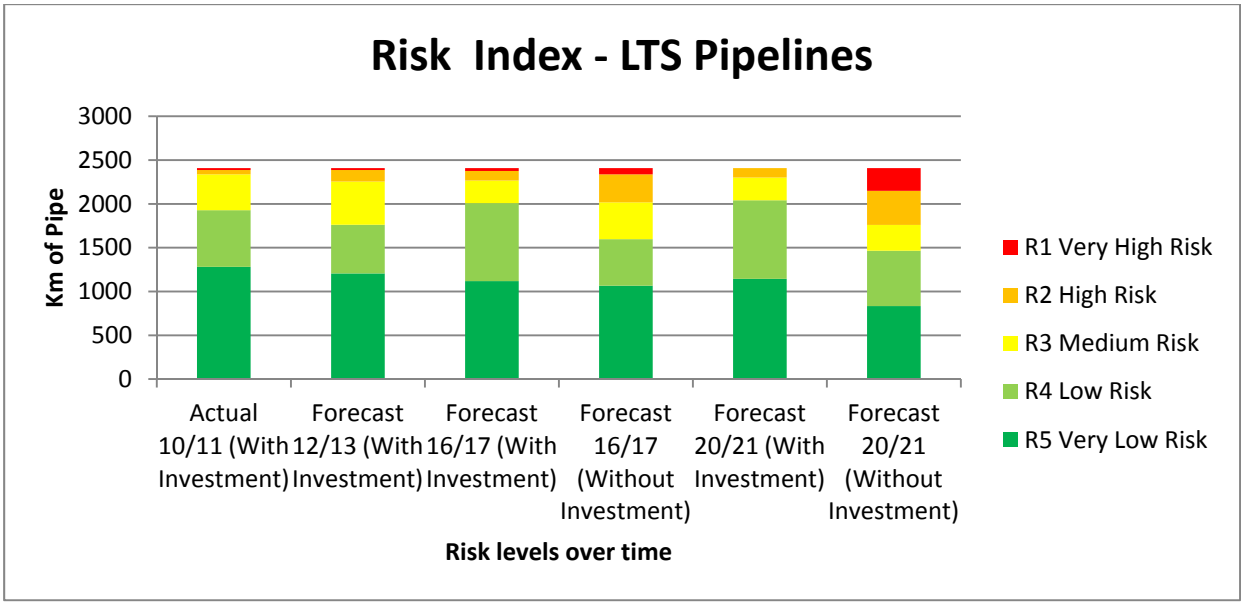
Consequence of Failure

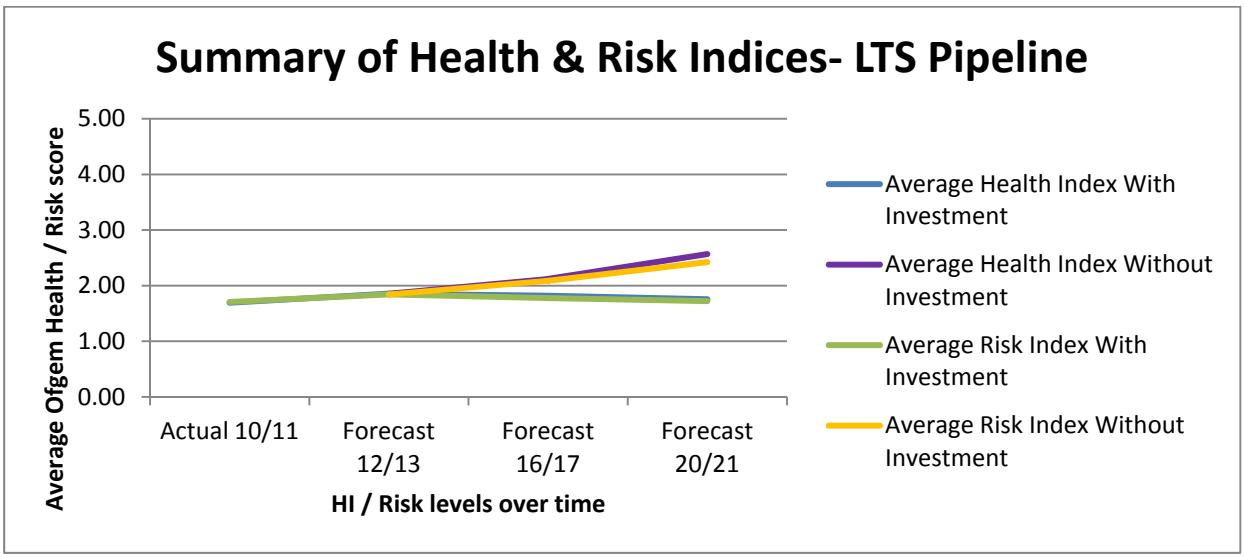
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum total of 15

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting aggregated Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- There are very few km of pipelines in the highest three risk categories and our intervention is targeted at maintaining this.
- Without investment, both the health index and risk increase which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets. This would include some pipelines failing to satisfy Pipeline Safety Regulations.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn is aimed at maintaining our current performance on the two primary output categories.

Confidence level in this data

Moderate: forecasts are based on a health only CBRM model.

Appendix 4. Block Valves

Asset Population

WWU has 27 above 7bar block valve sites (also known as bridle valves). The sites consist of a series of valves, above ground pipe work and associated equipment which allow gas to flow through the valve arrangement in a number of ways. The population is not expected to grow.

Health Index

All 27 sites were surveyed during the summer of 2011 to collect a range of data including current condition, environment and duty. The health index for this asset group is calculated from the ageing curve and is derived directly from the age of the block valve site, which in some cases has had to be assumed.

Ageing

WWU has developed an in house ageing curve for these assets based on the ageing curve developed for the CBRM models for other asset groups. The curve uses the algorithm from the CBRM model and the average asset life defined for this asset group and can be used to forecast the future Health Index score for each site at any future year. The block valve sites have been aged based on the above methodology to establish their health indices at various stages over the next price control period.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. Block valve sites have a consistent criticality rating of 3 (medium).

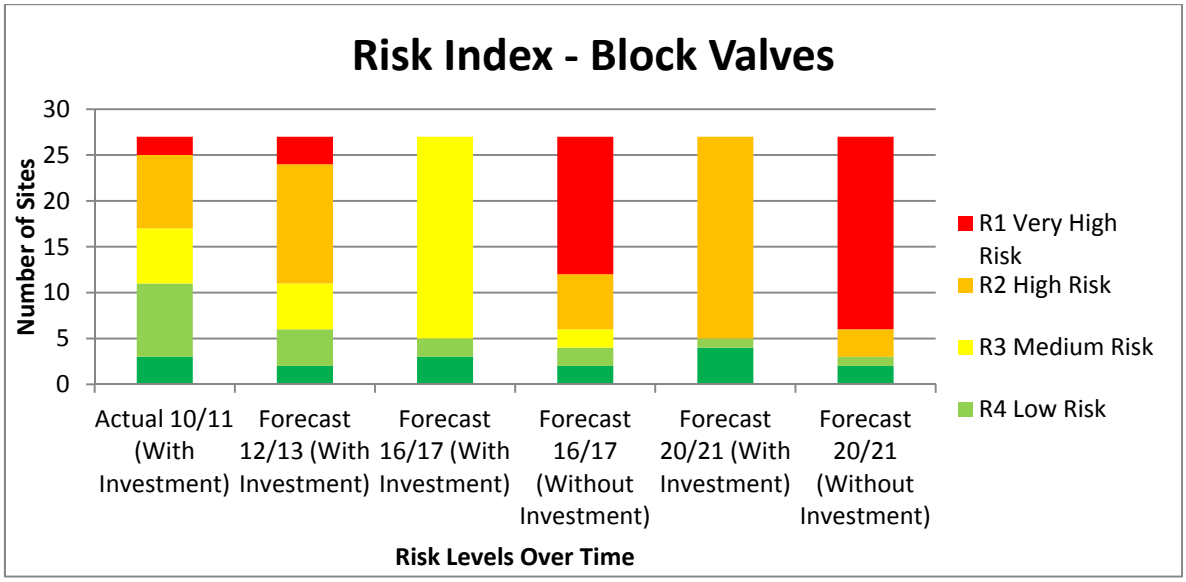
Consequence of Failure

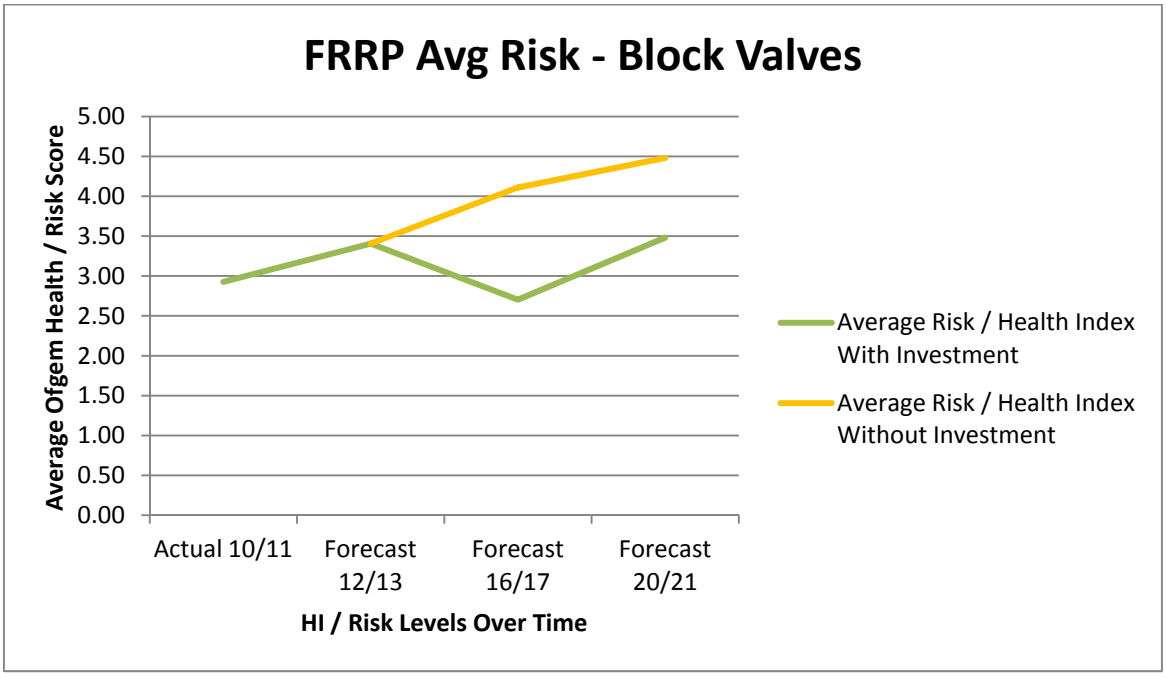
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a total of 10.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	×	×
Security of Supply	The cost to the consumer of being without gas	×	×	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	×	×	✓	×	×

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- There are few Block Valves in the highest risk categories and our intervention is targeting at maintaining this.
- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn is aimed at maintaining our current performance on the two primary output categories.

Confidence level in this data

Moderate: Health only CBRM model or other model/DST with known condition data.

Appendix 5. >7bar Special Crossings

Asset Population

WWU has 736 special crossings on the above 7bar pipeline network. These are above ground sections of pipeline crossing a variety of obstacles such as water courses, railways and roads. No growth is expected in the population of these assets.

Health Index

During the summer of 2010 asset data including material grade, coating type, operating pressure etc. for each crossing was gathered together. In addition condition data, principally coating condition, was attributed to this pipeline data. The combined data set was entered into a Condition Based Risk Management model that we had developed to produce a current Health Index in the range of 0.5 to 10 for each sleeve.

Ageing

The model has an ageing algorithm that forecasts the future Health Index score at each site in any given year. This algorithm has been produced in conjunction with an external asset management consultancy whose assumptions have been verified by university research.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, above 7 bar special crossings have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, and the Specified Minimum Yield Strength (SMYS) which would dictate the scale of release due to a failure.

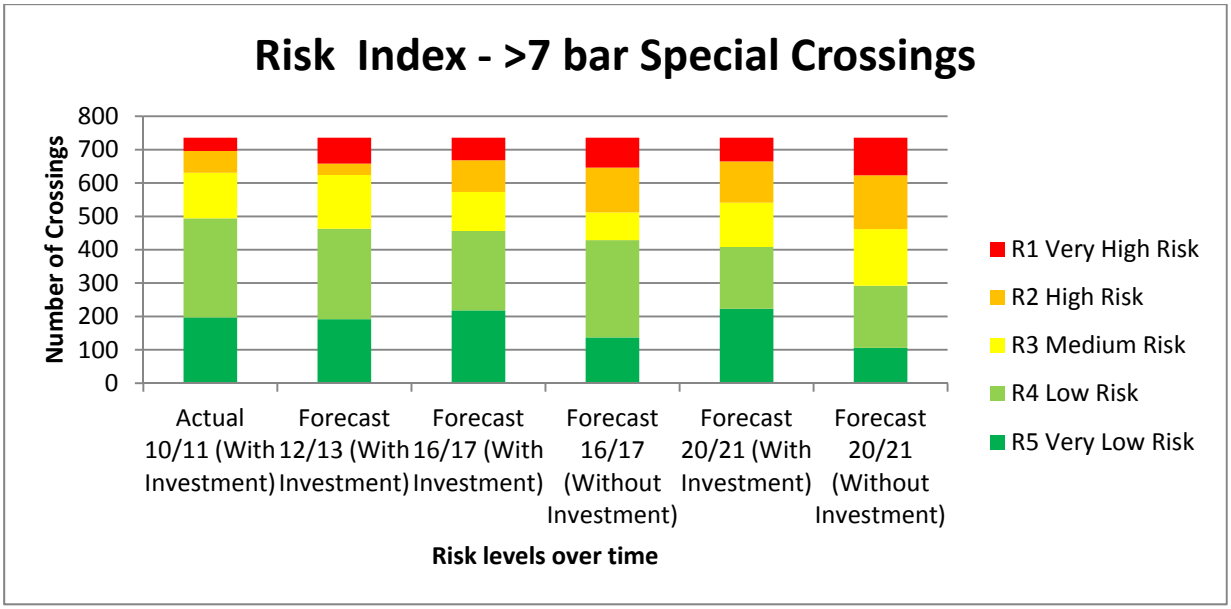
Consequence of Failure

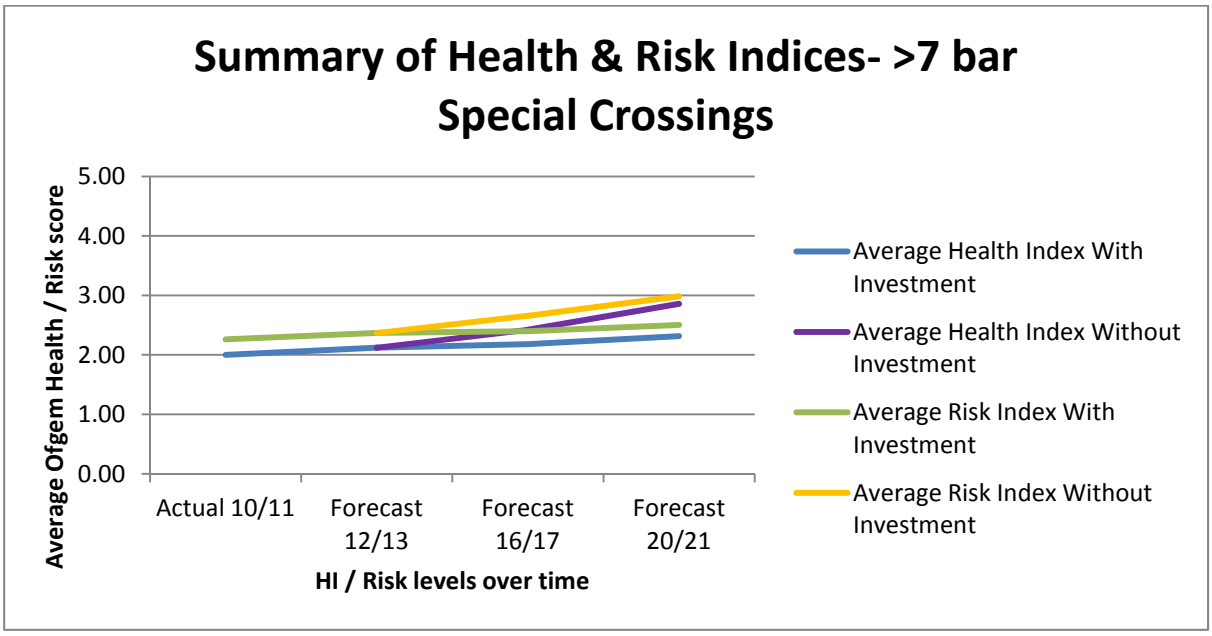
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum total of 15.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk begin to increase which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets (Pipelines Safety Regulations) 1996.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn are aimed at maintaining our current performance on the two primary output categories.
- There are very few special crossings in the highest three risk categories and our intervention is targeting at maintaining this.

Confidence level in this data

Moderate: forecasts are based on a health only CBRM model.

Appendix 6. Pipeline Inspection Gauge (PIG) Traps

Asset Population

There are 14 PIG traps within WWU that are not associated with a Pressure Regulation Installation and are in their own compound, with a further 49 that are within a Pressure Regulation Installation/Offtake compound. The PIG trap installation is an arrangement of valves and pipework and sometimes the PIG delivery/launch installation. No growth is expected in this asset group.

Health Index

Above 7 bar PIG traps were surveyed during the summer 2011 for a range of data including condition, environment and duty. Above 7 bar PIG traps health index is calculated from the ageing curve derived from the assumed age of the Block Valve.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and can be used to forecast the future Health Index totals at any given year.

Criticality

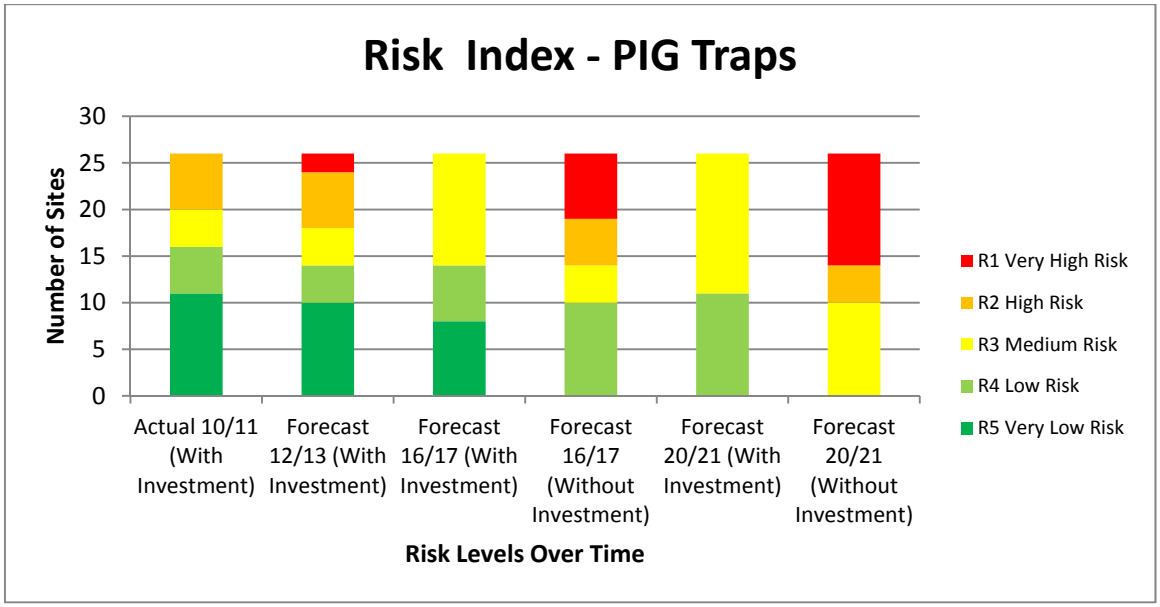
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. PIG traps have a consistent criticality rating of 3.

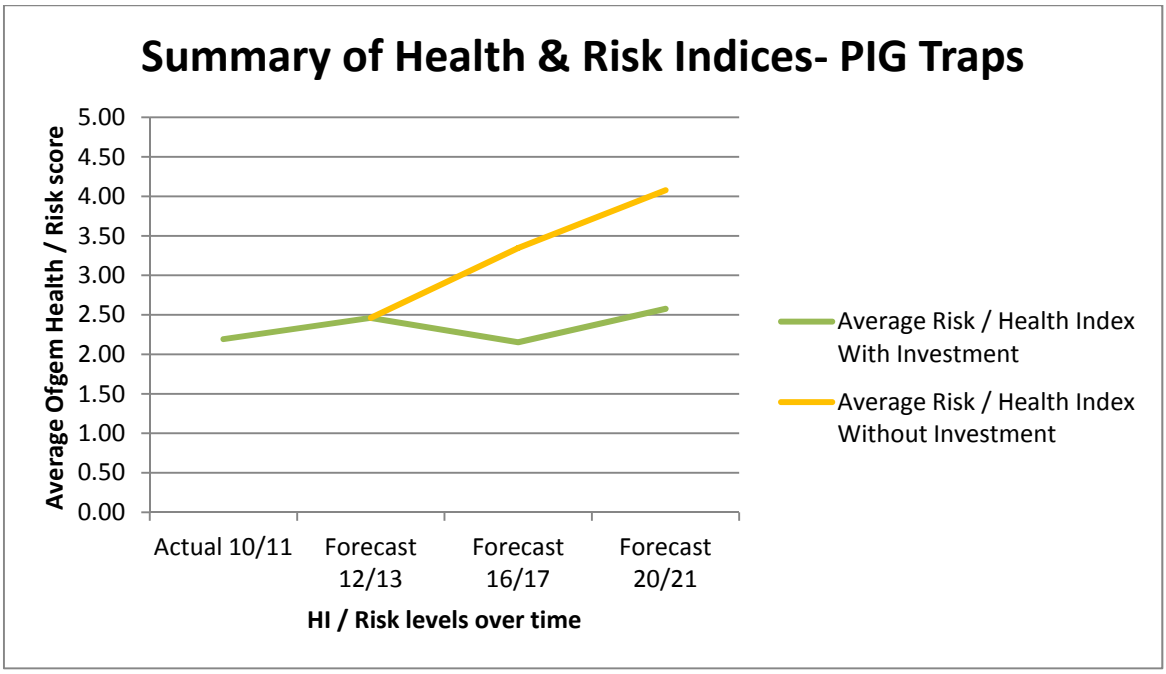
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 12.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	×	×	×	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	×	×	✓	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- There are few PIG Traps in the highest three risk categories and our intervention is targeted at maintaining this.
- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn is aimed at maintaining our current performance on the two primary output categories.

Confidence level in this data

Moderate: Health only CBRM model or other model/DST with known condition data.

Appendix 7. Sleeves - Nitrogen & Other

Asset Population

WWU has 102 Nitrogen filled sleeves installed on the above 7bar pipeline network. These are typically installed where the pipelines cross beneath roads or railway lines or are close to buildings, for protection at these vulnerable or safety critical locations.

Health Index

During the summer of 2010 asset data including sleeve class, end seal type, coating type, etc. for each sleeve was gathered together. In addition condition data including the level of Cathodic Protection (CP) and the sleeves ability to maintain a positive nitrogen pressure was attributed to this pipeline data. The combined data set was entered into a Condition Based Risk Management model that we had developed to produce a current Health Index in the range of 0.5 to 10 for each sleeve.

Ageing

The model has an ageing algorithm that forecasts the future Health Index score of each sleeve in any given year. This algorithm has been produced in conjunction with an external asset management consultancy whose assumptions have been verified by university research.

Growth of Asset Population

The population will not increase as the installation of sleeves is no longer permitted in design and construction codes, the population will only decrease if an existing pipeline is diverted, abandoned or down-rated.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, above 7 bar sleeves have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, and the Specified Minimum Yield Strength (SMYS) of the gas carrying pipeline.

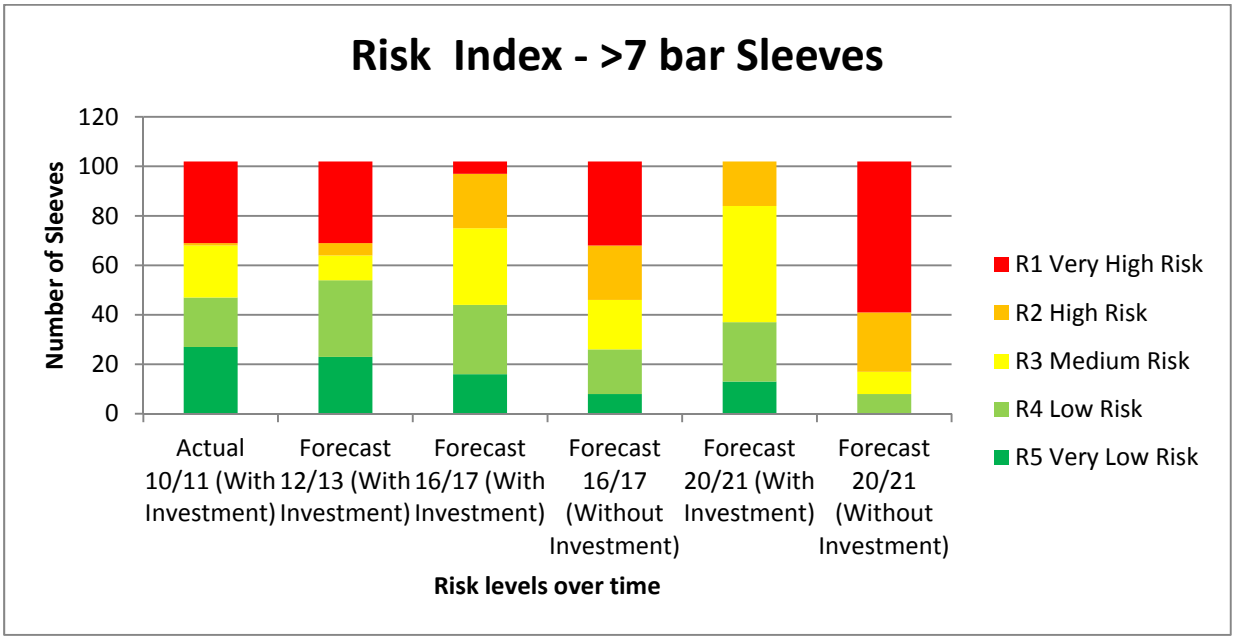
Consequence of Failure

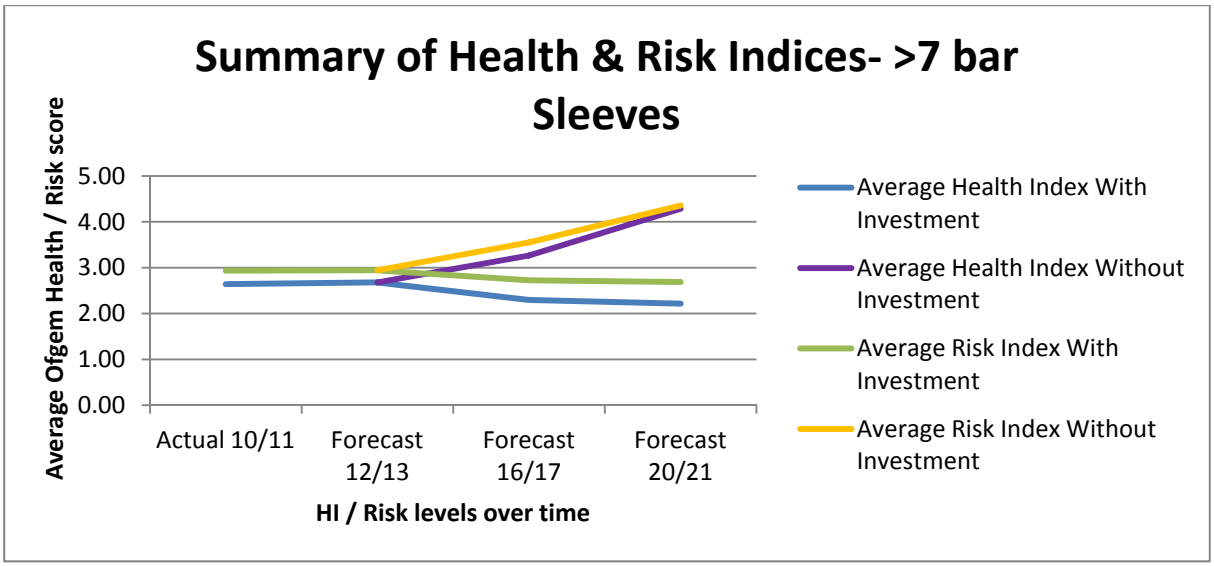
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum total of 14

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	✓	×

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk increase significantly which would not be an acceptable output position, where stakeholders have indicated that current levels of reliability are required.
- We are broadly maintaining asset health and risk indices with our proposed investment which is in accordance with stakeholder feedback. This will maintain compliance with the Pipelines Safety Regulations in an area of focus for the Health & Safety Executive.

Confidence level in this data

Moderate: forecasts are based on a health only CBRM model.

Appendix 8. Below 7 bar Special Crossings

Asset Population

WWU has 1,251 special crossings operating at pressures below 7 bar.

Growth of Asset Population

Any growth will be dependent upon the location of new connections and diversions.

Health Index

The health index for special crossings is determined by the condition and location of the main and the components of the crossing, for example condition of supports and wrapping status, and whether the crossing is above or below ground. The sum of these components goes towards a likelihood score which is then banded to give the health index.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for special crossings.

Criticality

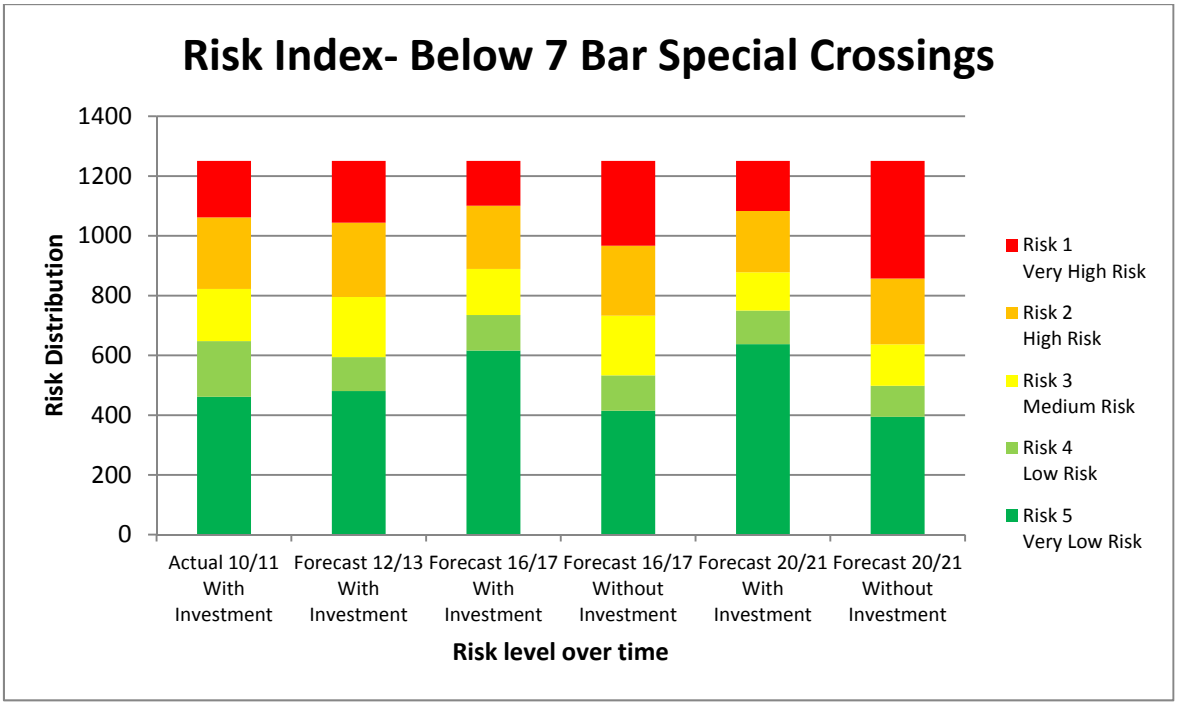
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for special crossings is a failure in the supports leading to the collapse of an above ground crossing, and a loss of supply to thousands of consumers.

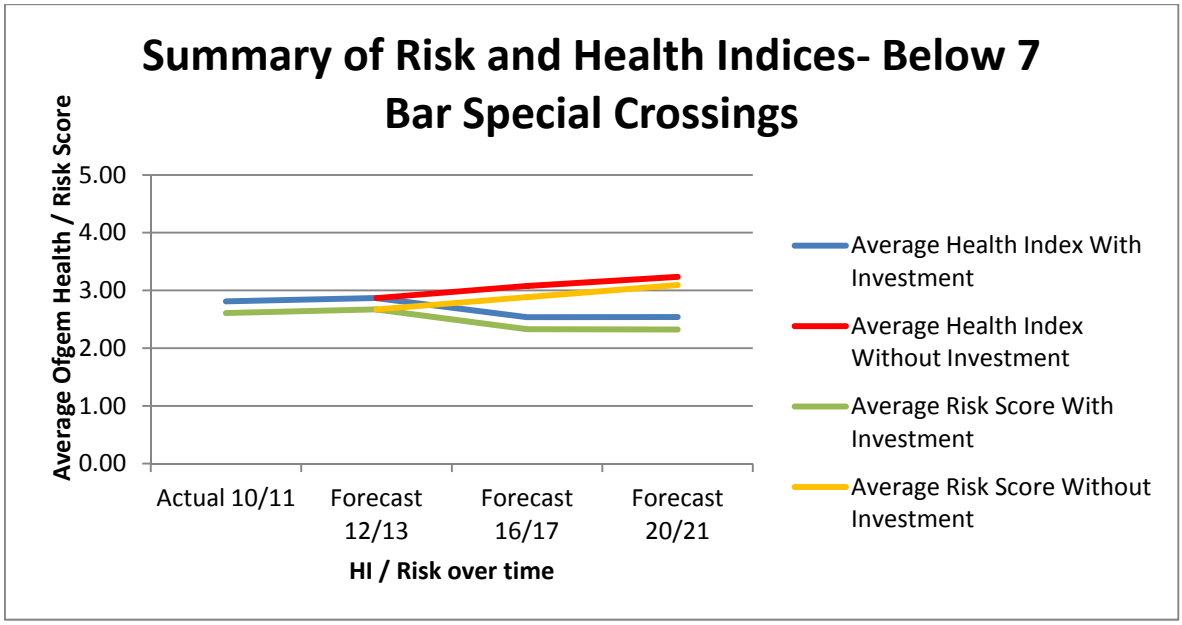
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 5 and a maximum total of 14.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	✓	✓	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- A high percentage of the special crossings population is in the higher risk categories at the start of the RIIO-GD1 formula period and our intervention is targeted at initially reducing this and then maintaining it at an acceptable level.
- Without investment both the health and risk index rise significantly which would not be an acceptable output position as we have legal requirements to maintain these assets.

Confidence level in this data

Moderate: Known population with consequence and likelihood model.

Appendix 9. Iron Distribution Mains

Asset Population

WWU has 32,190 km of distribution mains operating at pressures of 7 bar or below, of which 8,629km are iron mains.

Health Index

The health index for distribution mains is based on the material and age. For metallic mains, the health index is also determined through the condition score of the main. For example, new generation PE is HI1, whereas metallic pipes with a condition score greater than 0.5 are HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for distribution mains.

Criticality

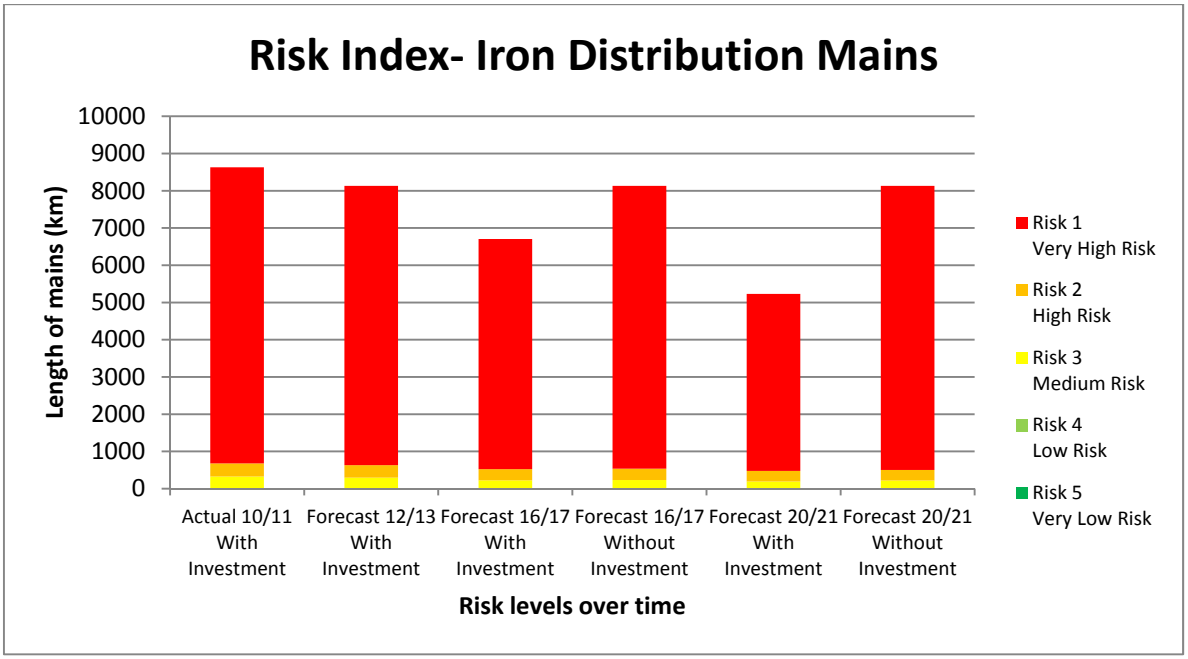
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, distribution mains have a range of criticalities in respect of the impact on consumers, such as numbers fed and proximity to buildings.

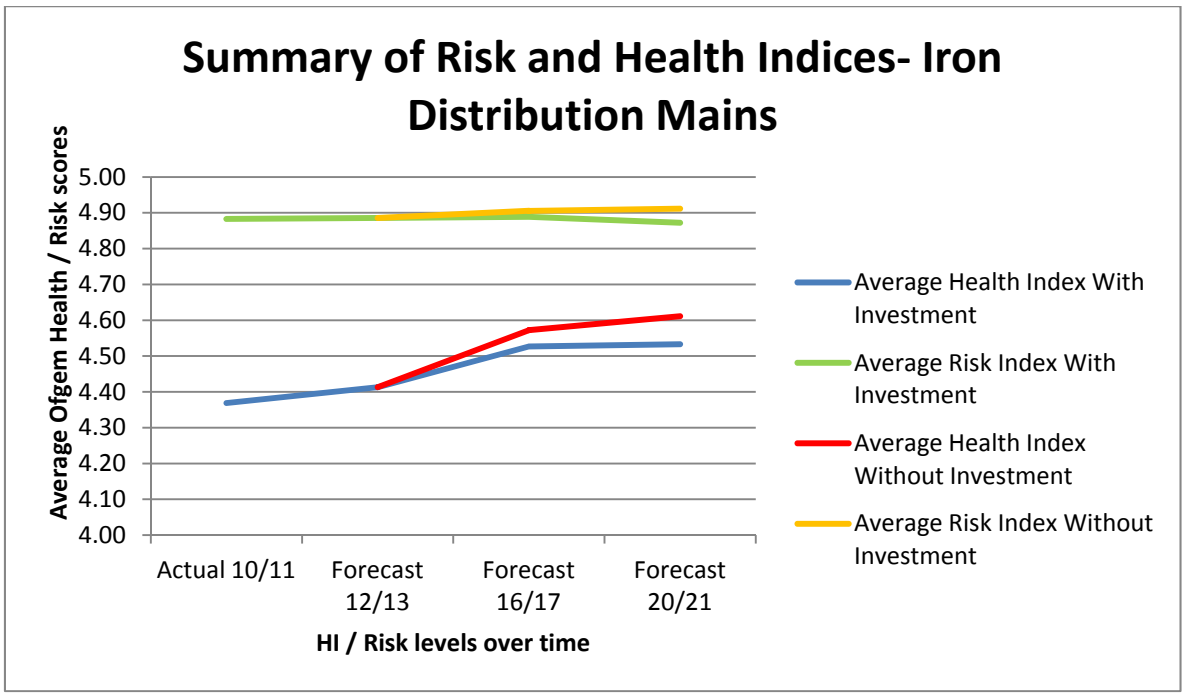
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 14.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	×	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	✓	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- The majority of the iron main population is in the highest risk category and our strategy is targeted at reducing this. This is only achieved by reducing the population by the decommissioning of these mains and replacing them with polyethylene under the iron mains replacement programme.
- Even with investment, health deteriorates, but with a risk based focus, the risk index improves slightly.

Confidence level in this data

Good: uses a Risk Prioritisation model considering both condition and risk.

Appendix 10. Steel Distribution Mains

Asset Population

WWU has 32,190km of distribution mains operating at pressures of 7 bar or below, of which 3,817km are steel distribution mains.

Growth of Asset Population

There is a small amount of new steel installed due to new connections where appropriate.

Health Index

The health index for distribution mains is based on the material and age. For metallic mains, the health index is also determined through the condition score of the main. For example, new generation PE is HI1, whereas metallic pipes with a condition score greater than 0.5 are HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for distribution mains.

Criticality

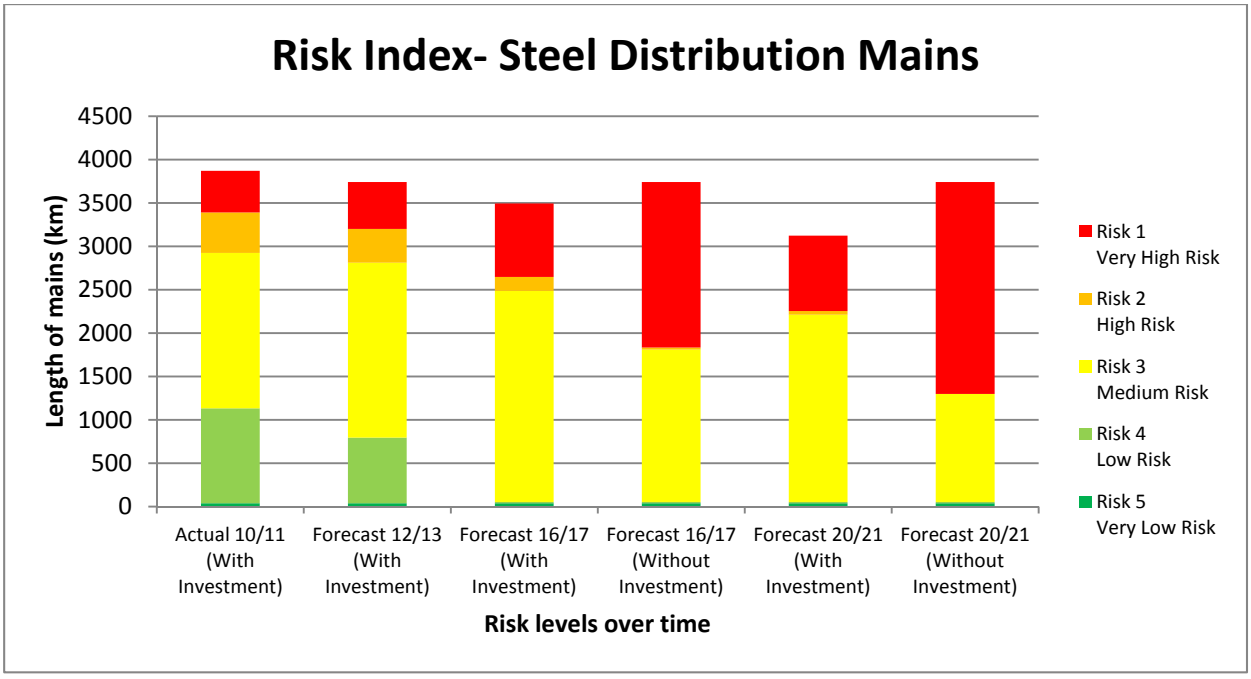
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, distribution mains have a range of criticalities in respect of the impact on consumers, such as numbers fed and proximity to buildings.

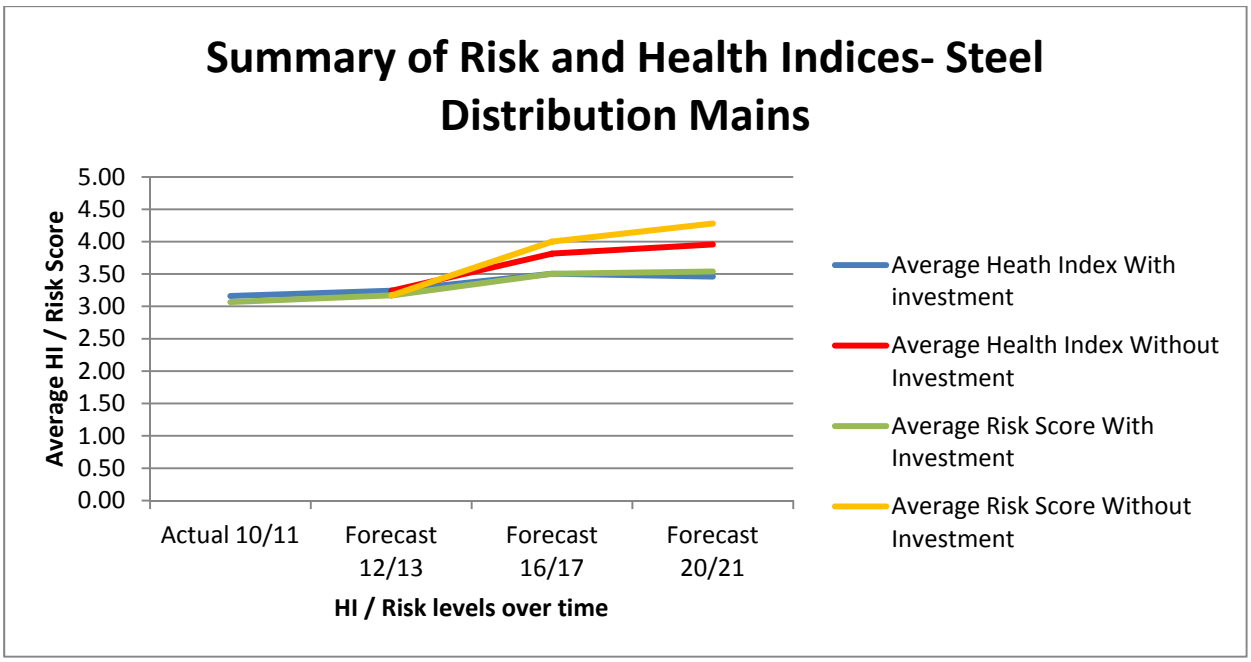
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 5 and a maximum total of 13.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	✓	✓	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	✓	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- The majority of the steel mains population is in the higher risk categories and our strategy is targeted at reducing this. This is only achieved by reducing the population by the decommissioning of these mains and replacing them with polyethylene.
- Even with investment, both health and risk increase. The investment is aimed at controlling this increase, but does result in increased emissions and repairs. This is mitigated by investment in other asset groups, such as iron mains, where additional safety benefits result.

Confidence level in this data

Moderate: uses a condition based model with known population.

Appendix 11. Polyethylene Distribution Mains

Asset Population

WWU has 32,190km of distribution mains operating at pressures of 7 bar or below, of which 19,743km are polyethylene mains.

Growth of Asset Population

It has been assumed that an additional 60km of new mains will be laid every year; these will be laid in new generation polyethylene. The proposed workload for decommissioning existing metallic mains around 460km every year up to 2020/21, the majority being replaced with polyethylene.

Health Index

The health index for distribution mains is based on the material and age. For polyethylene, new generation polyethylene is considered to be HI1.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for distribution mains.

Criticality

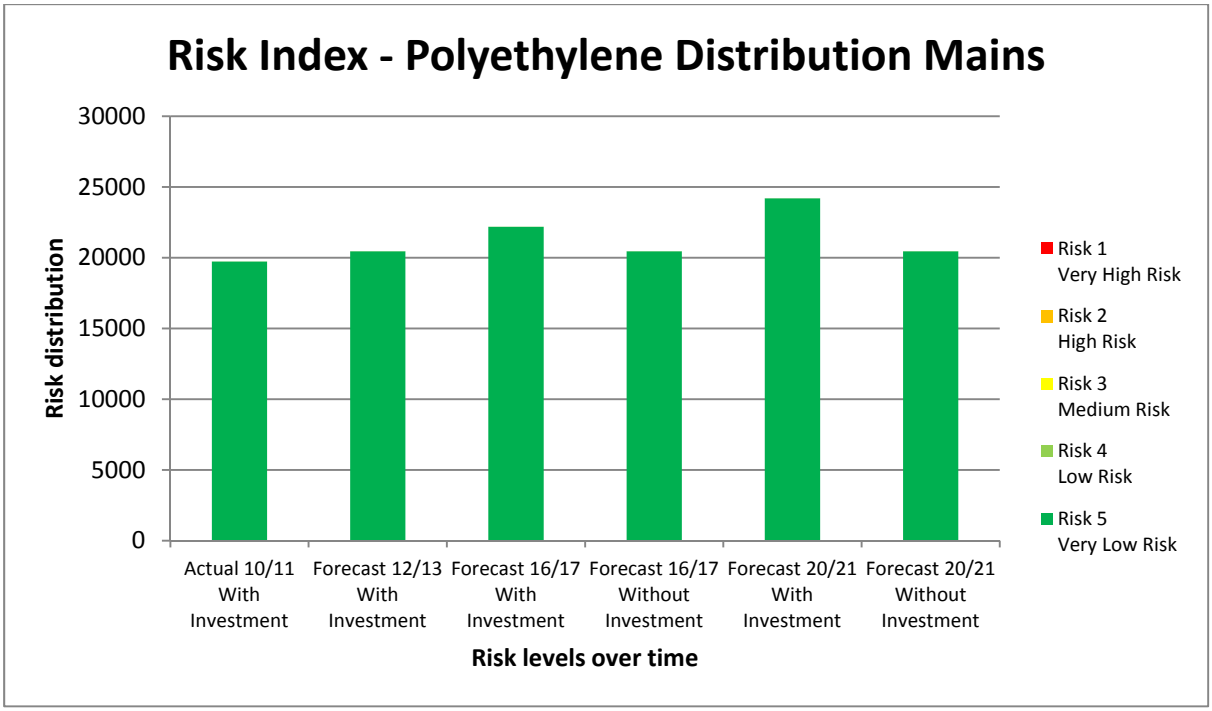
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, distribution mains have a range of criticalities in respect of the impact on consumers, such as numbers fed and proximity to buildings.

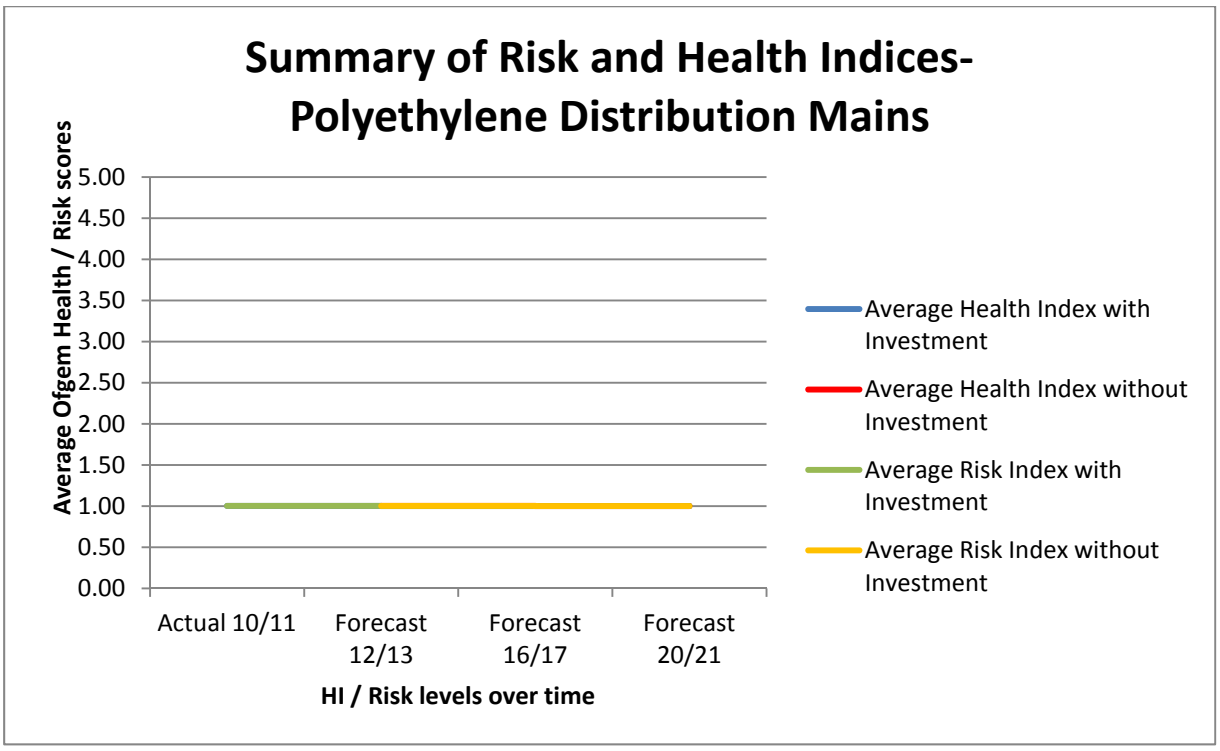
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 4 and a maximum total of 11.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	✓	×	×	×
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	✓	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Polyethylene will not deteriorate over the course of the 2013-2021 period.
- We are not intending to improve health or risk which will broadly maintain asset health and risk indices.

Confidence level in this data

Moderate: Known population but limited condition data and no model. However, failure data indicates condition to be good.

Appendix 12. Other Distribution Mains

Asset Population

WWU has 32,190km of distribution mains operating at pressures of 7 bar or below, of which 1.5km are mains other than iron, steel, or PE. These include asbestos, copper, and PVC.

Health Index

The health index for distribution mains is based on the material and age. For metallic mains, the health index is also determined through the condition score of the main. For example, new generation PE is HI1, whereas metallic pipes with a condition score greater than 0.5 are HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for distribution mains.

Criticality

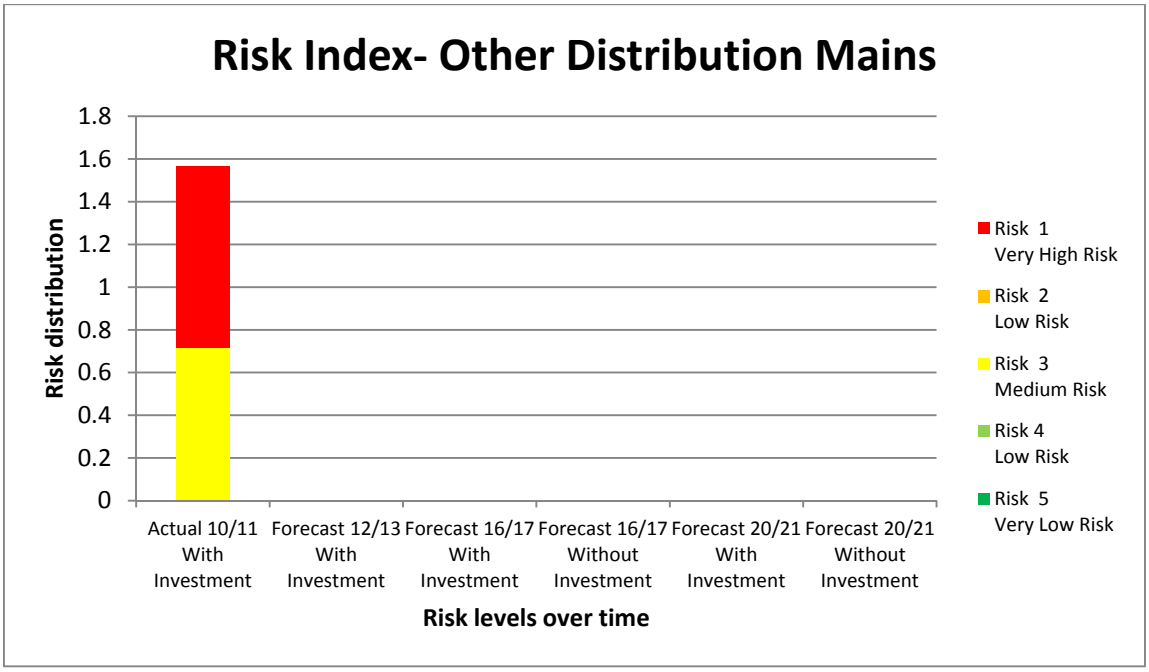
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, distribution mains have a range of criticalities in respect of the impact on consumers, such as numbers fed and proximity to buildings.

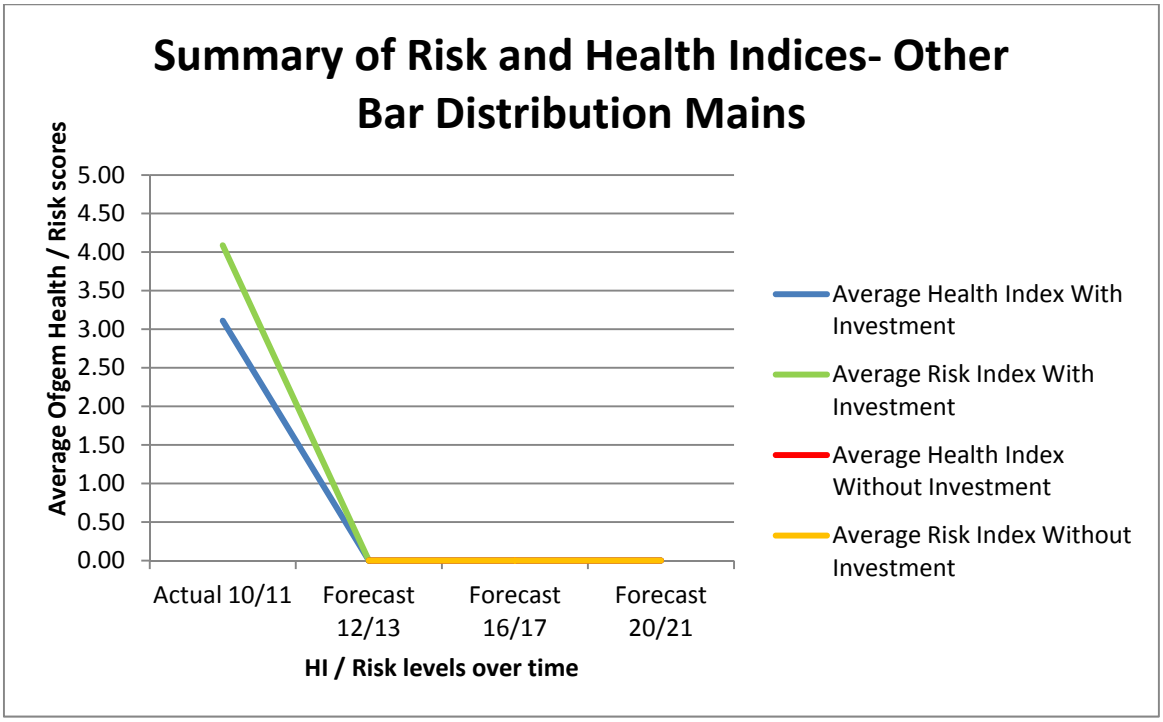
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 8 and a maximum total of 11.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	×	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- All mains classified as “other” will be replaced before 2013.
- To satisfy Pipeline Safety Regulations requirements, we are reducing asset health and risk indices to zero with our proposed interventions.

Confidence level in this data

Low: Known population but limited condition data and no model.

Appendix 13. Polyethylene Services

Asset Population

WWU has circa 1.8m polyethylene services within the network.

Growth of Asset Population

There is expected to be an additional 10,000 connections made each year, which will be laid in new generation polyethylene.

Health Index

The health index for services is based on the material. For metallic services, the health index is also determined through postcode analysis and leakage. For example, polyethylene with electro-fused joints is HI1, whereas steel in the replacement programme or in postcode analysis is HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for services. It has been assumed that the curve for polyethylene services is virtually flat.

Criticality

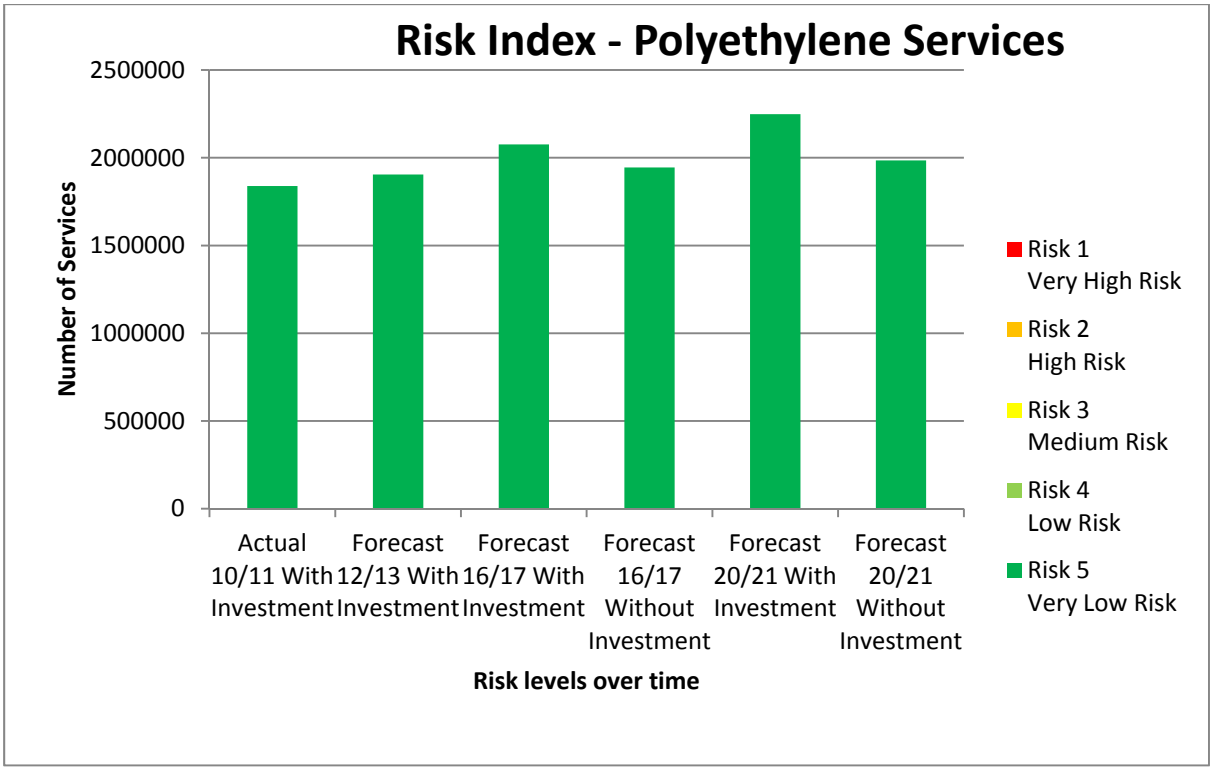
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for services is a leak resulting in gas in buildings, leading to explosions.

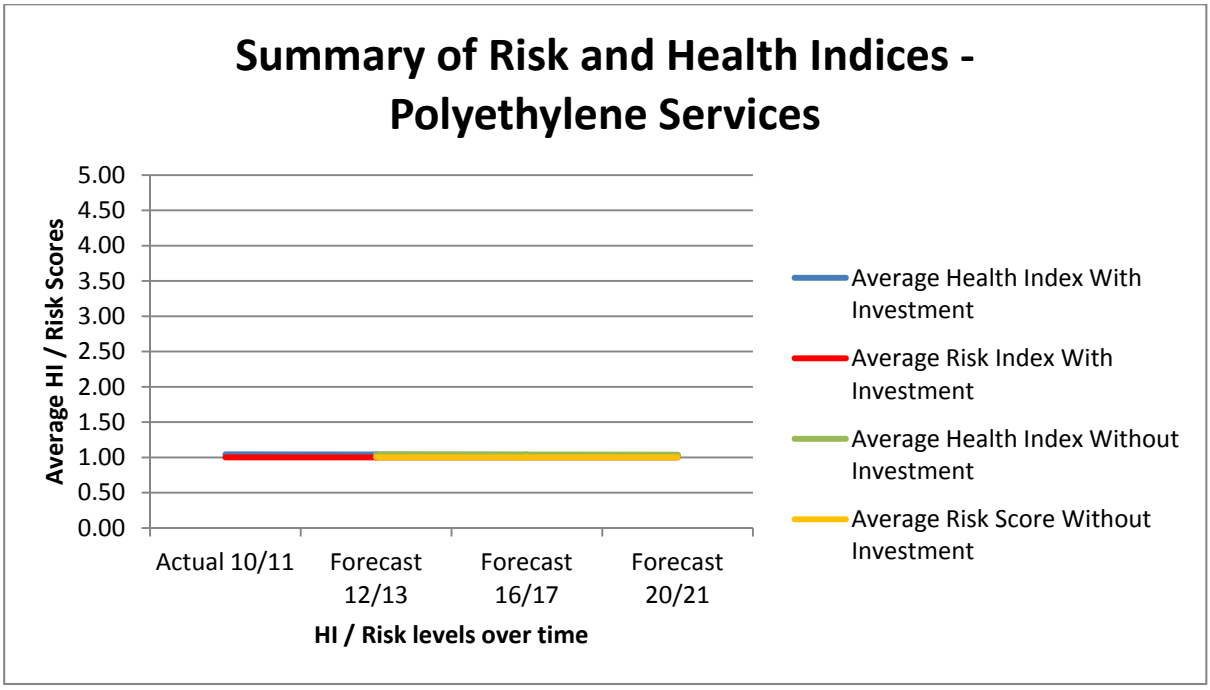
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 4 and a maximum total of 5.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	✓	×	×	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- without investment, both the health index and risk stay at the current low level which would be an acceptable output position.
- the population of the asset group is increasing as metallic services are replaced and new connections are installed.

Confidence level in this data

Moderate: known population but limited condition data and no model. However, failure data indicates that condition is good.

Appendix 14. Steel and Other Metallic Services

Asset Population

WWU has circa 528,000 steel and other non-polyethylene services within the network.

Growth of Asset Population

There is expected to be an additional 10,000 connections made each year, which will be laid in new generation polyethylene. Where required new steel services may also be laid.

Health Index

The health index for services is based on the material. For metallic services, the health index is also determined through postcode analysis and leakage. For example, PE with electro-fused joints is HI1, whereas steel in a postcode hotspot is HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for services.

Criticality

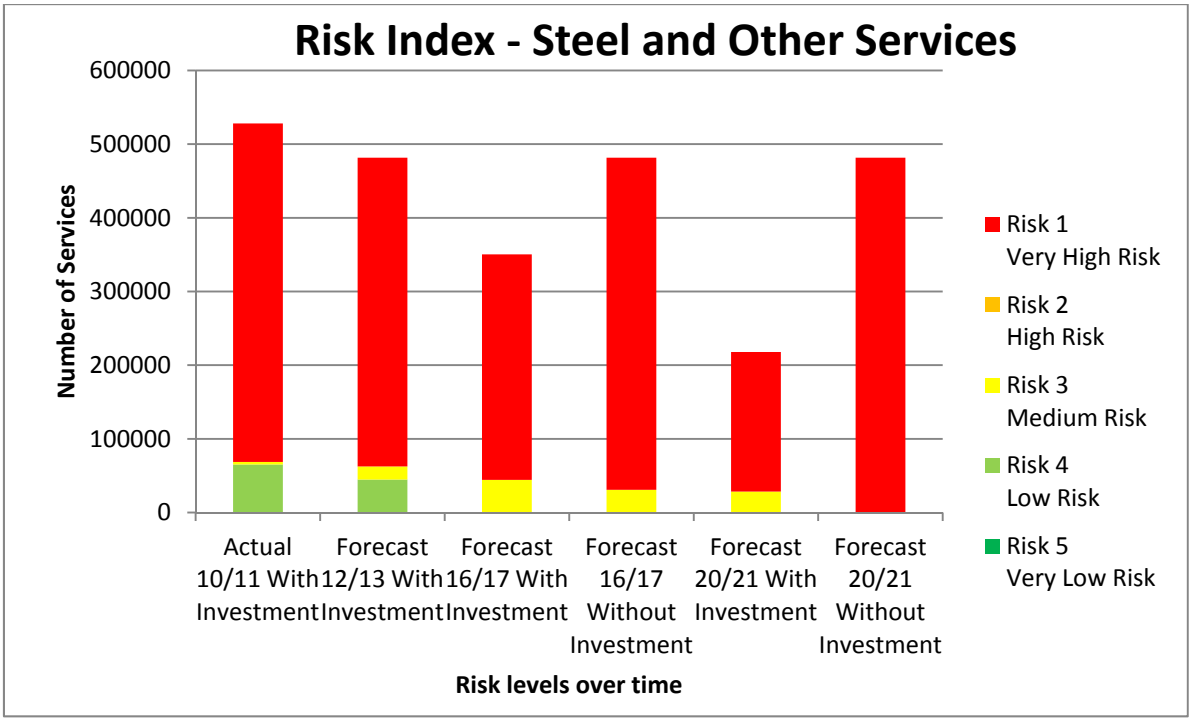
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for services is a leak resulting in gas in buildings, leading to explosions.

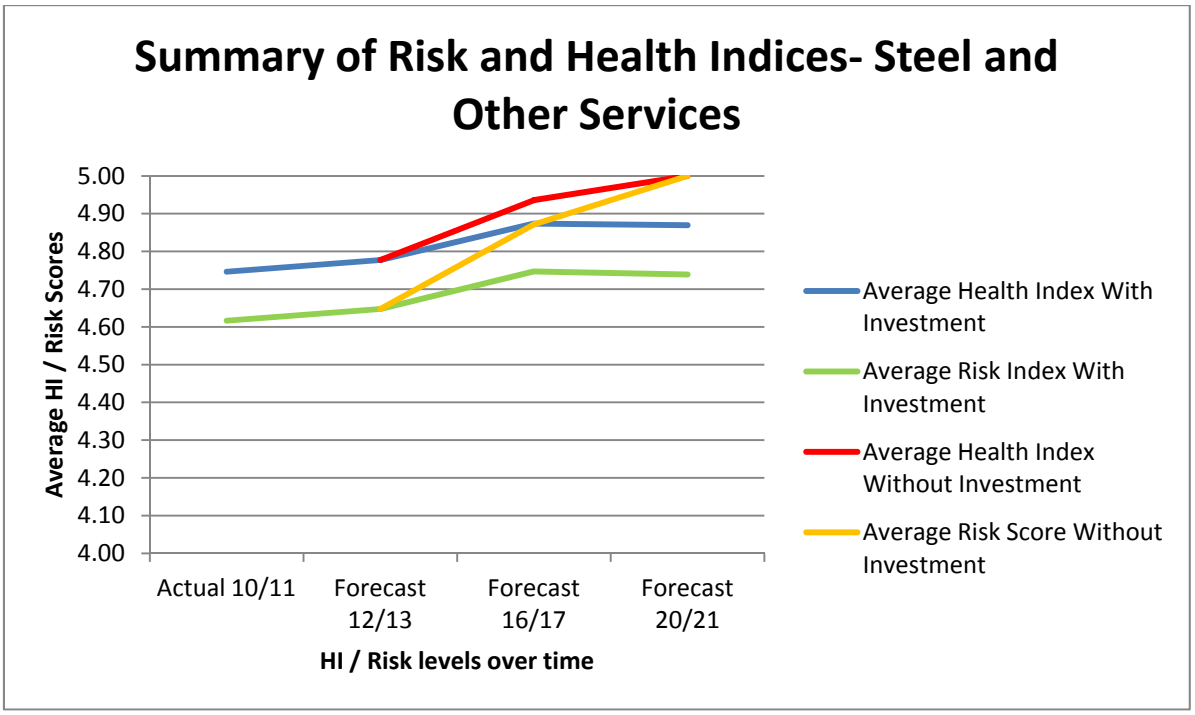
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 8.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- The vast majority of the steel and other service population is in the highest risk categories and our strategy is targeted at reducing this. This is only achieved by reducing the population by the replacement of the metallic services with polyethylene.

Confidence level in this data

Moderate: known population but limited condition data and no model. However, failure data indicates condition is poor.

Appendix 15. Risers

Asset Population

WWU currently have 7,073 risers, of which 256 are populated in the high rise database and 6,817 are calculated based on the assumption that there is one riser for each low rise multi occupancy building.

Growth of Asset Population

Growth will be dependent on new connections and installations.

Health Index

The health index for risers is determined by their condition. The sum of the components goes towards the condition score, which is then banded to provide the health index.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index totals at any given year for risers.

Criticality

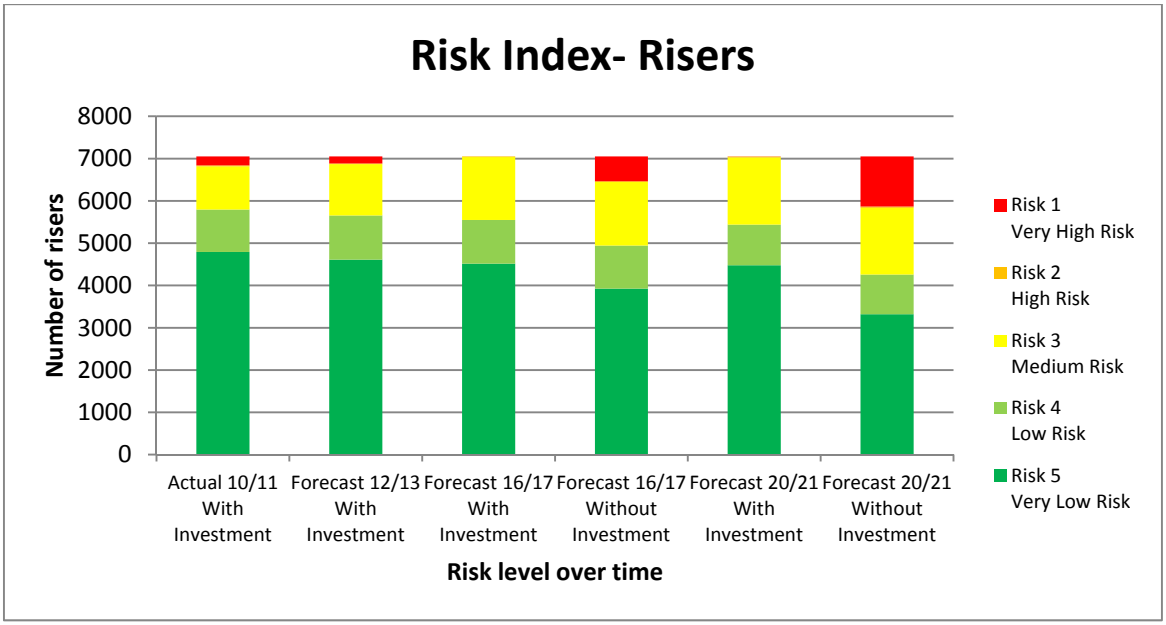
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for mains is a leak resulting in gas in buildings, leading to explosions.

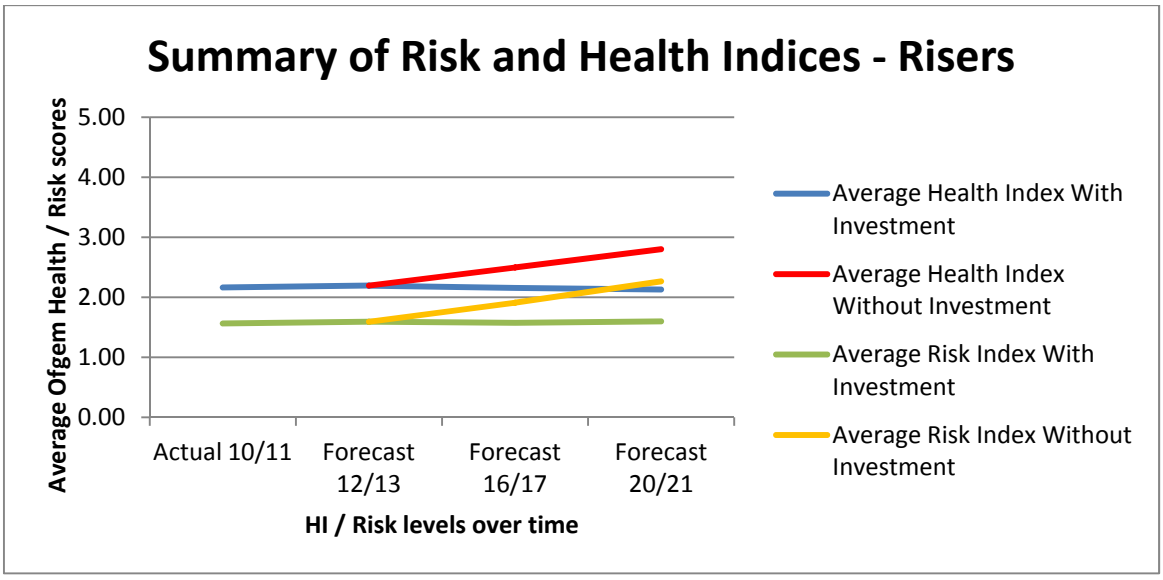
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum total of 10.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- A low percentage of the multi occupancy building population is in the highest risk categories at the start of the RIIO-GD1 period and our intervention is targeted at maintaining this.
- Without investment, both the health index and risk rise significantly which would not be an acceptable output position as we have legal obligations to maintain these assets, and because stakeholders have indicated that current levels of reliability are required to be maintained.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed intervention strategy which is aimed at maintaining our current performance on the primary output categories.

Confidence level in this data

Low: known population with full condition data and model for high rise, and limited condition data with no model for low rise.

Appendix 16. Valves

Asset Population

WWU has an estimated 14,344 Valves, 4,650 IP, 3052 MP and 6,643 LP. The population has been estimated using by evaluating IP Valve drawings to get a sample ratio per km of pipe. The Ratios used are 3 per km for IP, 0.75 per km for MP and 0.25 per km for LP.

Health Index

There is little legacy data available for Valves. The age distribution has been estimated using the age of below 7bar distribution pipes to plot all assets on an exponential curve to produce a Health Index score of 0.5 to 10.

Ageing

The exponential curve used is based on the CBRM model which has an ageing algorithm that forecasts the future Health Index score at each site in any given year. This algorithm has been produced in conjunction with an external asset management consultancy, who have had their assumptions verified by university research.

Criticality

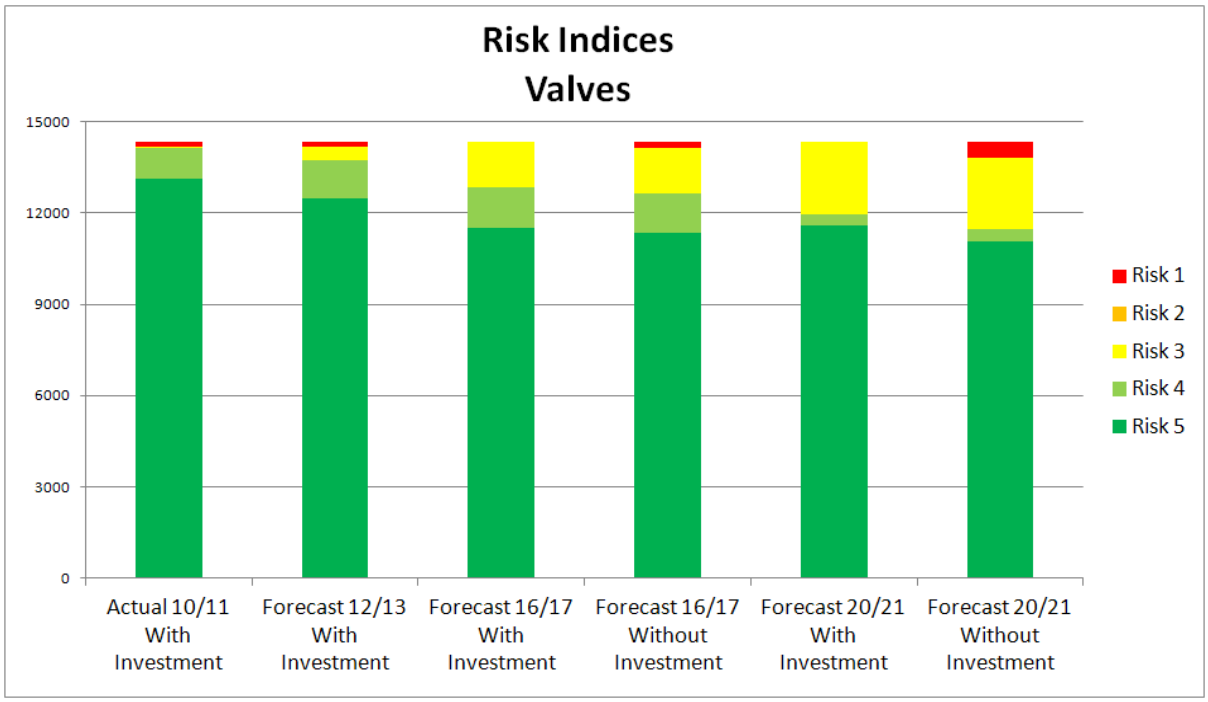
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. Valves are all low criticality assets.

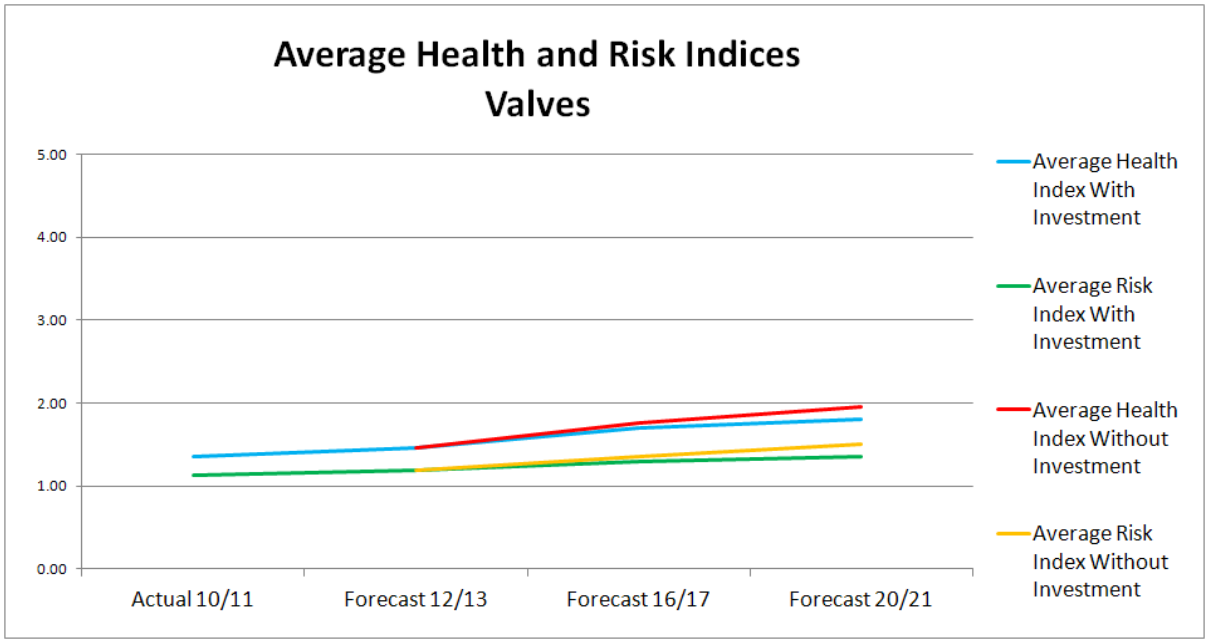
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 7.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise which, given the relatively low risk, would be an acceptable output position. The replacement or removal of valves shown above is associated with mains replacement.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions.

Confidence level in this data

Very Low - Incomplete population data, no model and no condition data.

Appendix 17. High Pressure Vessels

Asset Population

WWU have 15 high pressure storage vessels (bullets) over 3 sites (Weston Super Mare, Cheltenham and Bristol). For the purposes of categorising the Health Index of these assets all bullets on the same site will be classed as a single asset because they will have experienced the same deterioration mechanisms, operating conditions, maintenance and other condition related factors. No change to the asset population is expected.

Health Index

The health index for high pressure storage vessel is related to the number of pressure cycles completed against its fatigue life and the time elapsed since its last revalidation. Each vessel has a defined number of pressure cycles before it reaches its fatigue life, the number of pressure cycles the vessel has remaining is one indicator of its health. In addition each vessel requires periodic revalidation (assessment of its defects) without which it can no longer be operated. The time elapsed since the last revalidation is another indicator of the vessels health index. Of the two scores the larger will be used to represent the health index at any point in time.

Ageing

Ageing is based on forecast pressure cycles (taken from the GL Noble Denton 20 yearly re-validation reports) and the time remaining until the next revalidation.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, high pressure storage vessels have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Location and Storage Capacity.

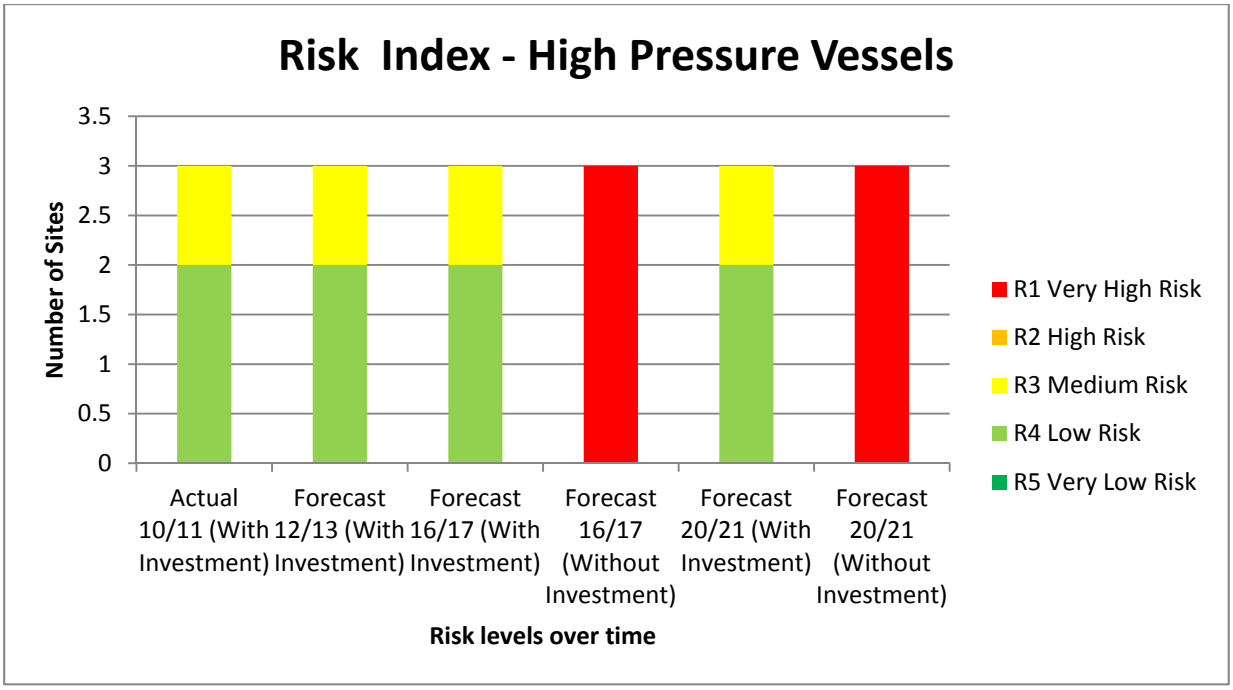
Consequence of Failure

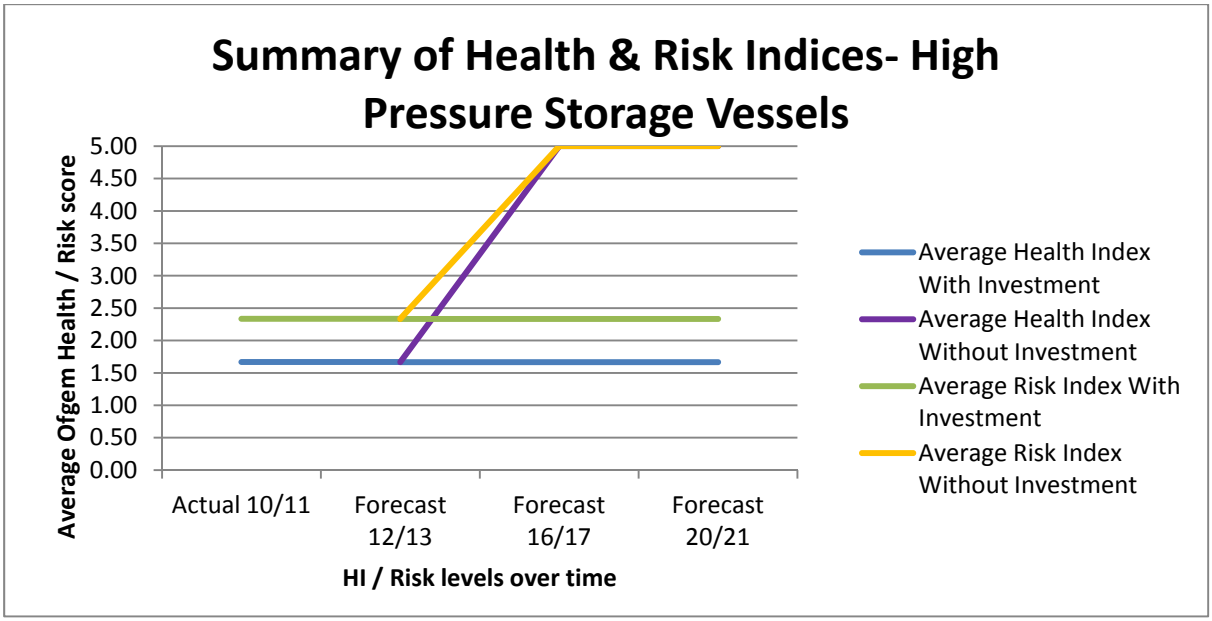
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 12.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	×	×
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk index increase significantly which would ultimately result in the inability to operate the high pressure vessels. This reflects the requirement for 5 yearly revalidation.
- We are broadly maintaining asset health and risk indices with our proposed investment which is accordance with what stakeholders requested.
- There are no high pressure vessels in the highest risk categories and our intervention is targeting at maintaining this.

Confidence level in this data

Moderate: forecasts are based on a combination of time to validation and pressure cycles experienced and is based on the latest inspections.

Appendix 18. Operational Holders

Asset Population

WWU has 4 operational holders over 3 sites (Plymouth, Bath and Exeter x 2). These holders are used to store gas at less than 75mbar and release it during times of peak daily demand. WWU forecast that all currently operational holders will be decommissioned during the next price control period as these are considered a high risk asset group. As a result WWU forecast a 0 HI towards the end of the next price control period as there will be no operational holders remaining.

Health Index

The health index for each operational holder is related to its age. The average expected asset life of a holder has been established based on historical failure data and is estimated at 80 years. The health index has been directly correlated to the age of the holder at that point it time.

Ageing

WWU have developed an in house ageing curve based on that used in the CBRM models developed for other asset groups. The curve uses the algorithm from the CBRM model and the average asset life for this asset group and can be used to forecast the future Health Index per site at future given year. The operational holders have been aged based on the above methodology to establish their health indices at various stages over the next price control period.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, operational holders have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Location and Storage Capacity.

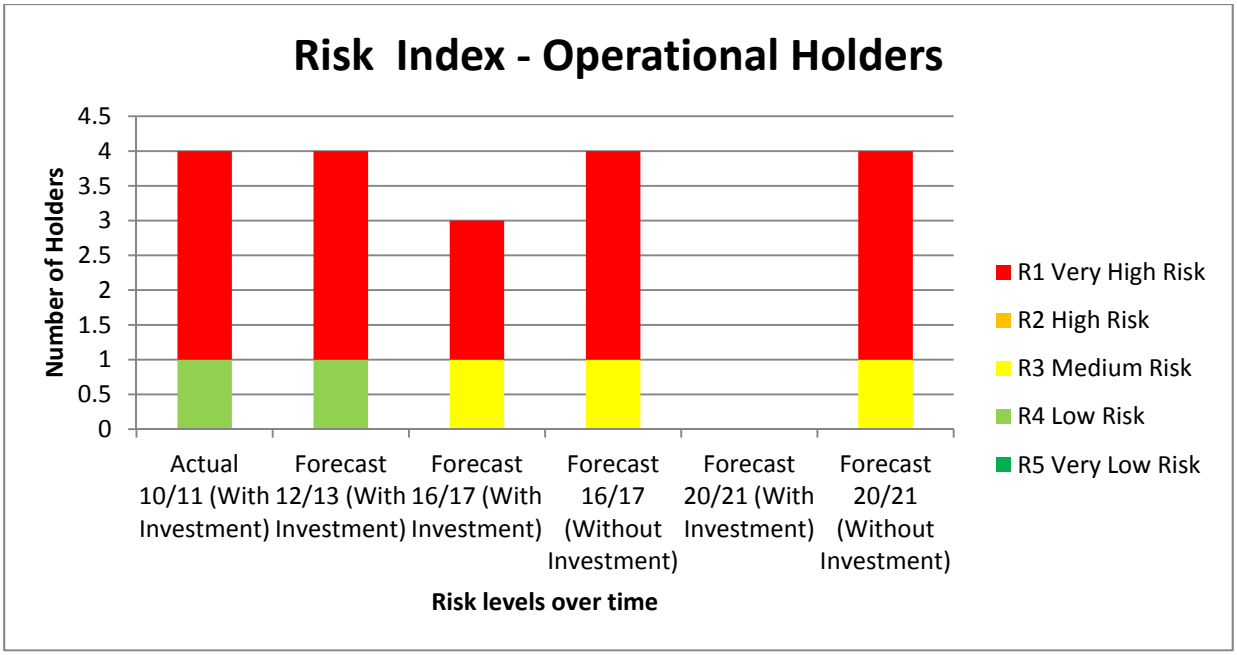
Consequence of Failure

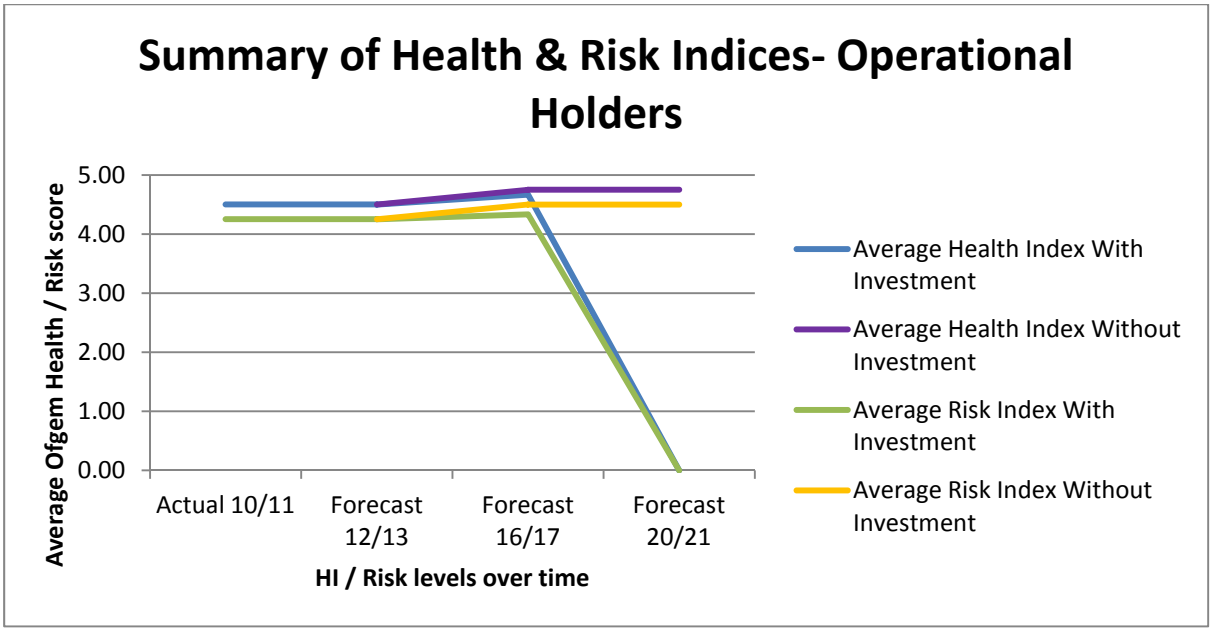
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a total of 6 and a maximum score of 6.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	×	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment to decommission, both the health and risk remain significantly high with the continued operation of the holders.
- We are removing the inherent risk in the assets by removing them from operation and utilising alternative means of gas storage (e.g. line pack) which carries significantly reduced levels of risk.

Confidence level in this data

Moderate: forecasts are based reliable historical data and ages, but these assets are prone to unexpected failures such as below ground tank failure.

Appendix 19. Non Operational Holders

Asset Population

WWU currently has 22 non-operational holders over 13 sites[11]. These holders were historically used to store gas but are no longer required by the network and so are currently in a purged state awaiting planned demolition. Eleven of these will be demolished during this current price control review period from 2008 to 2013. There are a further 4 operational holders over 3 sites which will become non-operational during the next price control period. These and the remaining purged holders are planned to be demolished in the next price control review period from 2013 to 2021.

Health Index

The health index for a non-operational holder is related to its age. The average expected asset life of a holder has been established based on historical failure data and is estimated at 80 years. The health index has been directly correlated to the age of the holder at that point it time.

Ageing

WWU has developed an in house ageing curve based on the ageing curve developed for the CBRM models for other asset groups. The curve uses the algorithm from the CBRM model and the average asset life for this asset group and can be used to forecast the future Health Index score for each site at any future year. The non-operational holders have been aged based on the above methodology to establish their health indices at various stages over the next price control period.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, non-operational holders have a range of criticalities in respect of their impact on environmental surroundings and the health and safety of people on site.

Consequence of Failure

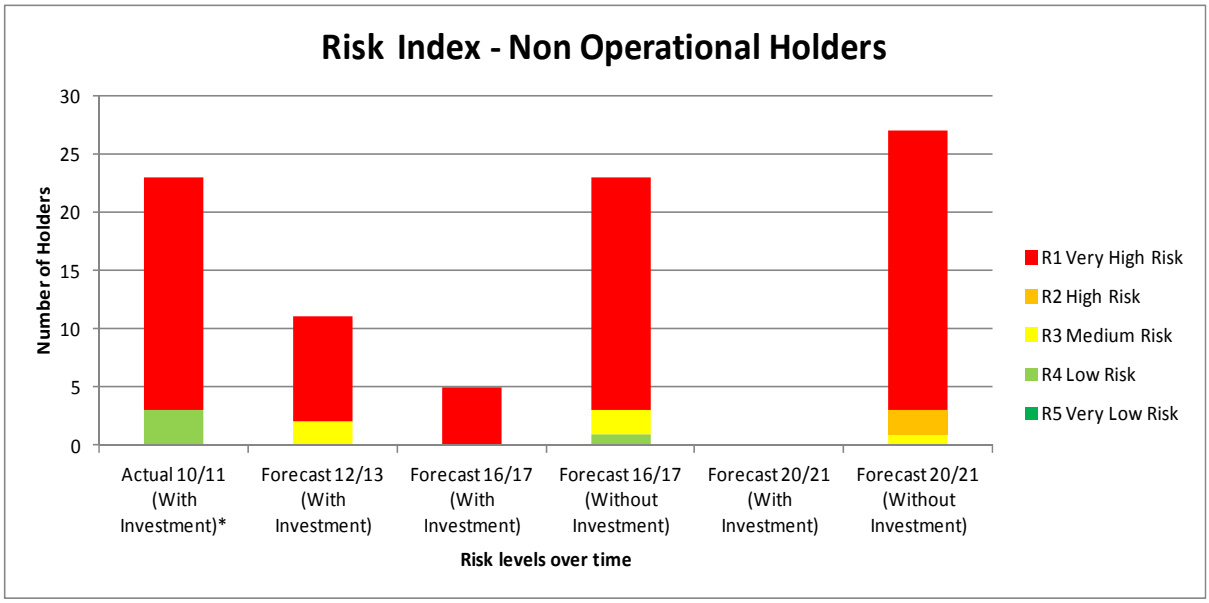
We have defined the worst credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 8 and a maximum total of 8.

[11] Number accurate as at August 2011

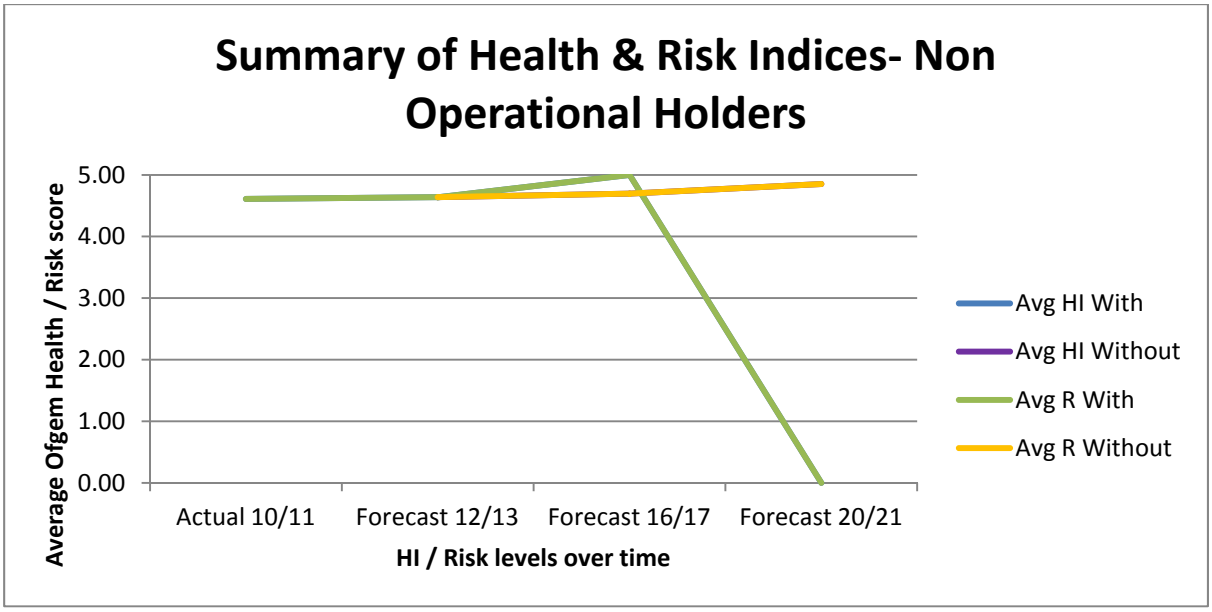
Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	×	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	×	×	✓	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-



*As at August 2011



These graphs illustrate that:-

- Without investment, both the health and risk remain significantly high representing a high amount of risk being present within the continued presence of the decommissioned holders.
- We are removing the inherent risk in the assets by demolishing them.

Confidence level in this data

Low: forecasts are based solely on age.

Appendix 20. National Transmission System Offtakes

Asset Population

WWU has 17 Offtakes, these are the point of gas entry into the WWU network from the National Transmission System. The Offtakes range significantly in size passing between 16,000 scm/h feeding around 20,000 consumers and 358,000 scm/h feeding hundreds of thousands of domestic, commercial and industrial properties. No growth is expected in the population of these assets.

Health Index

Offtakes were surveyed during the summer of 2010 for a range of data including condition, environment and duty. This survey data combined with asset data such as pressure range and faults has been entered into a Condition Based Risk Management model developed to produce a current Health Index of 0.5 to 10.

Ageing

The model has an ageing algorithm that forecasts the future Health Index in any given year. This algorithm has been produced in conjunction with an external asset management consultancy whose assumptions have been verified by university research.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, Offtakes have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Outlet Pressure, Network Configuration and Location.

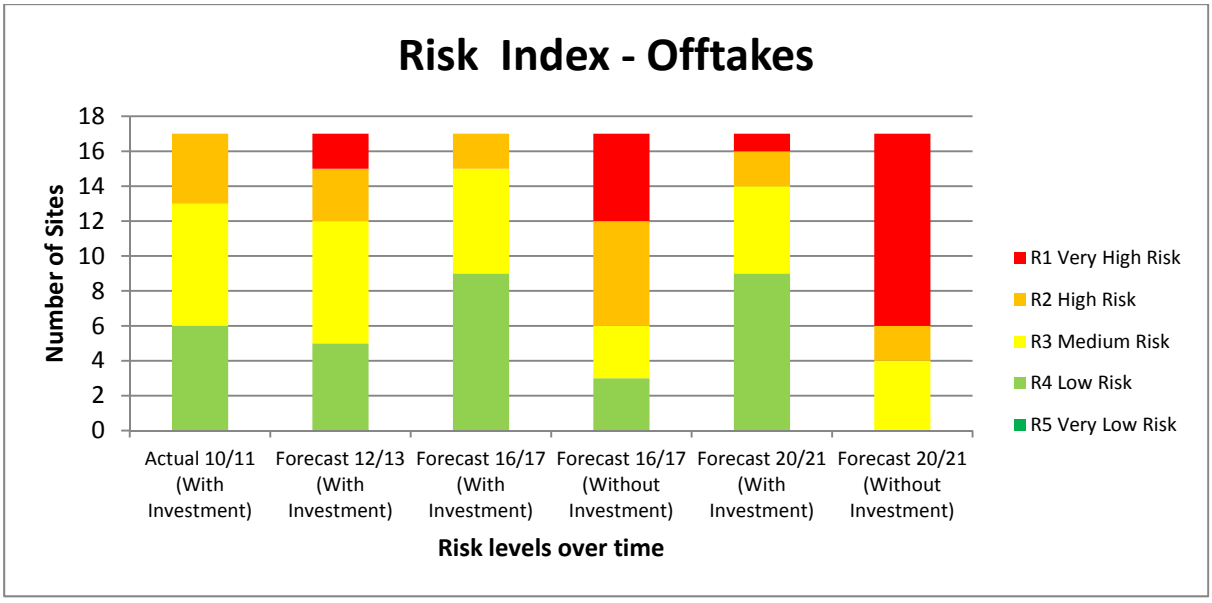
Consequence of Failure

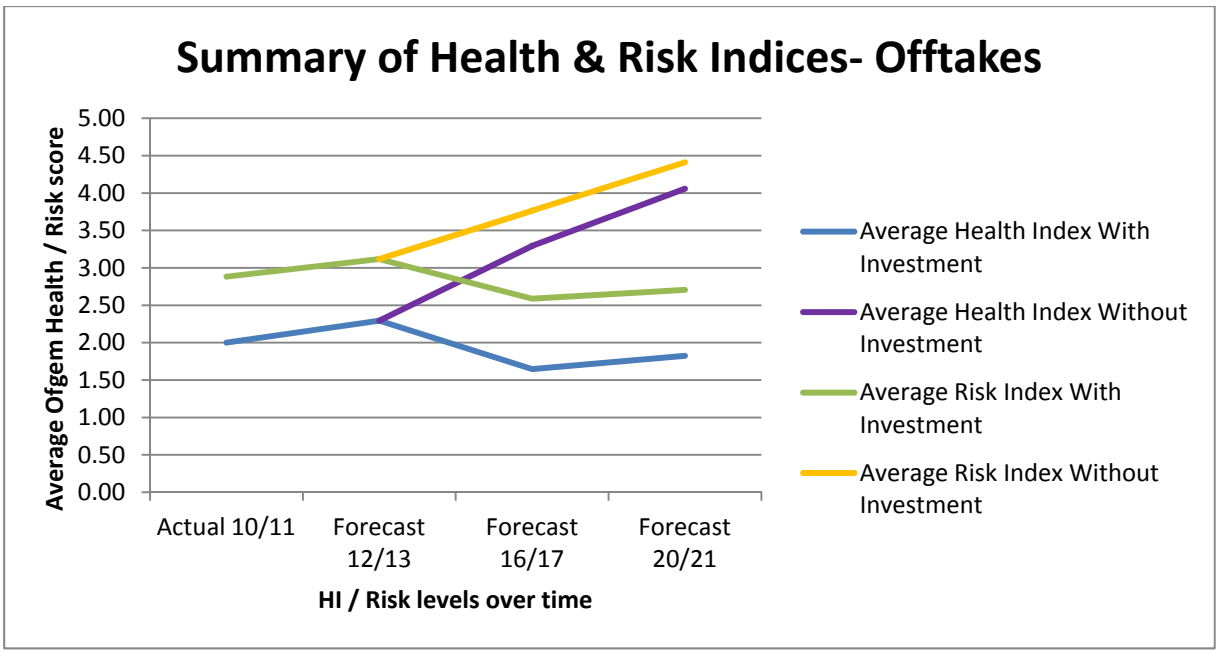
We have defined the worst credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum score of 15.-

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- We are broadly maintaining asset health and risk indices with our proposed investment which is accordance with stakeholder feedback.
- There are very few offtakes in the highest risk categories and our intervention is targeting at maintaining this.

Confidence level in this data

Moderate: current HI has a high confidence, but future HI forecasts are based on the CBRM model and methodology which is in its infancy in the gas sector.

Appendix 21. Pressure Regulating Installations above 7 bar

Asset Population

WWU has 331 above 7 bar pressure regulating installations. These range significantly in size passing between 1 scm/h feeding 1 domestic consumer and 253,000 scm/h feeding hundreds of thousands of domestic, commercial and industrial properties. No growth is expected in the population of these assets.

Health Index

Pressure regulating installations were surveyed during the summer 2010 for a range of data including condition, environment and duty. This survey data combined with asset data such as pressure range and fault history has been entered into a Condition Based Risk Management model developed to allocate a current Health Index of 0.5 to 10.

Ageing

The model has an ageing algorithm that forecasts the future Health Index in any given year. This algorithm has been produced in conjunction with an external asset management consultancy whose assumptions have been verified by university research.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, pressure regulating installations have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Inlet Pressure, Network Configuration and Location.

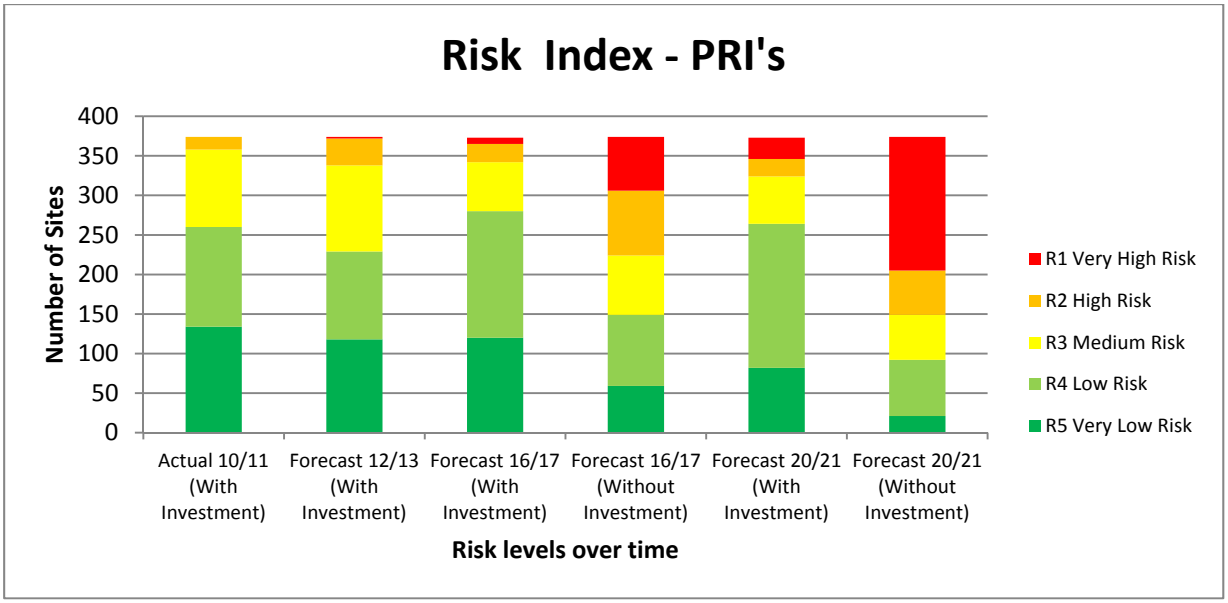
Consequence of Failure

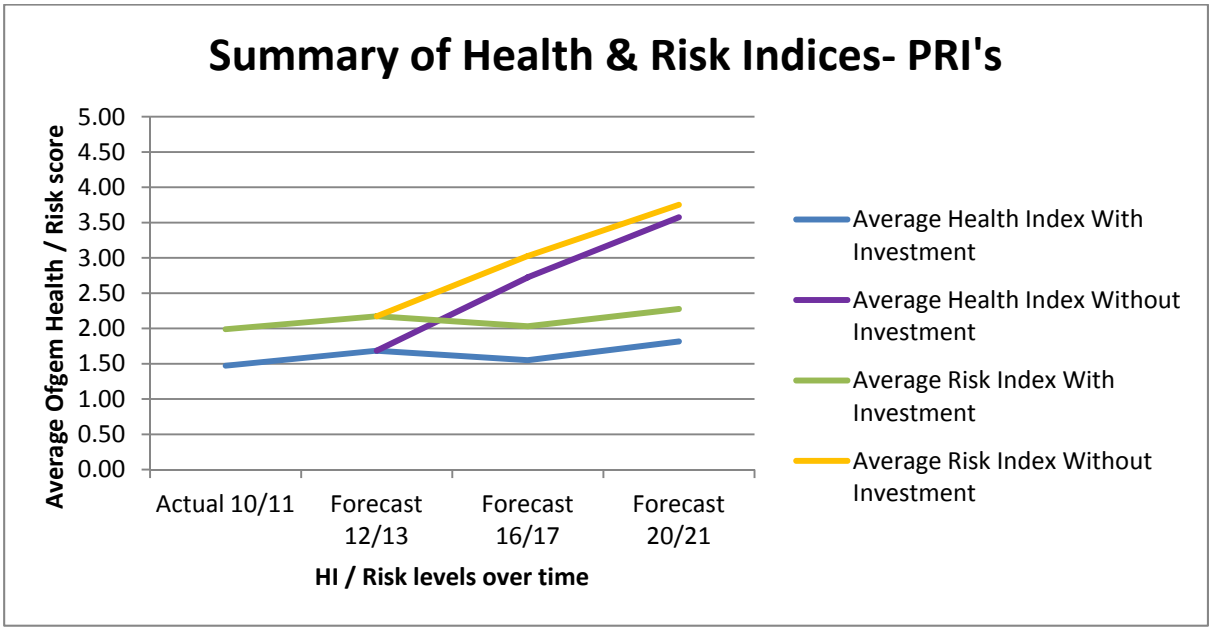
We have defined the worst credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum score of 15.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	×	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- We are broadly maintaining asset health and risk indices with our proposed investment which is accordance with stakeholder feedback.
- There are very few pressure regulating installations in the highest three risk categories and our intervention is targeting at maintaining this.

Confidence level in this data

Moderate: current HI has a high confidence, but future HI forecasts are based on the CBRM model and methodology which is in its infancy in the gas sector.

Appendix 22. District Governors

Asset Population

WWU has 2,872 District Governors, with an estimated 2,220 feeding domestic premises and 652 feeding Industrial & Commercial premises.

Growth of Asset Population

The population only grows through installation of new sites, either to reduce the risk associated with individual sites with high consumer numbers; or where localised increase in demand occurs, such as new housing development. In the first category, 31 district governors will be installed over the first two years of RIIO-GD1, this will remove risk from “high” and “medium” and the new sites will be added to the “low” risk.

Health Index

District Governors were surveyed during the summer 2010 for a range of data including condition, environment and duty. This survey data combined with asset data such as pressure range and faults is entered into the Condition Based Risk Management model to produce a Health Index score of 0.5 to 10.

Ageing

The model has an ageing algorithm that forecasts the future Health Index score at each site in any given year. This algorithm has been produced in conjunction with an external asset management consultancy, who have had their assumptions verified by university research.

Criticality

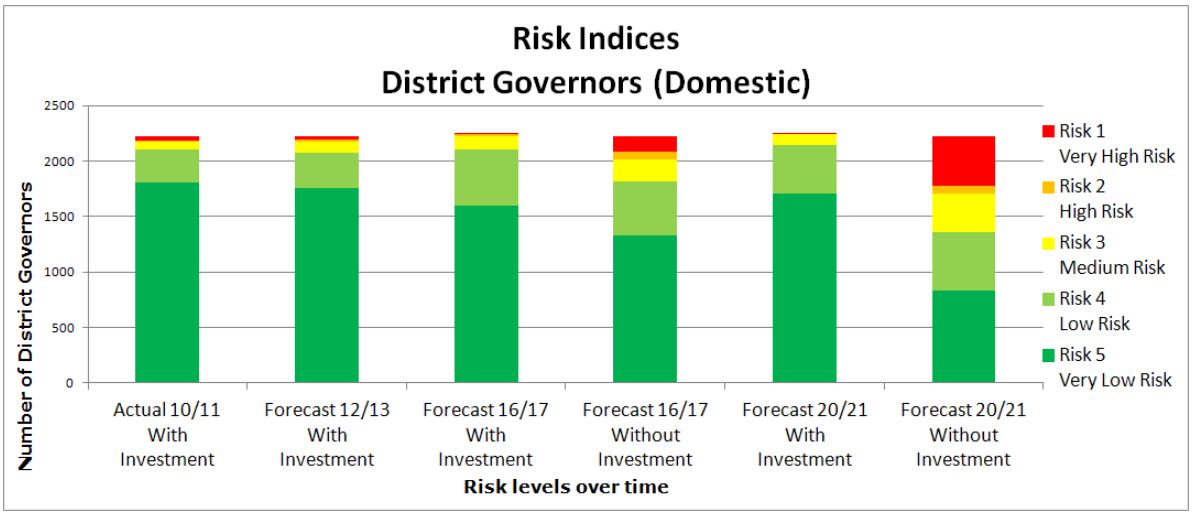
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, district governors have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Inlet Pressure, Network Configuration and Location.

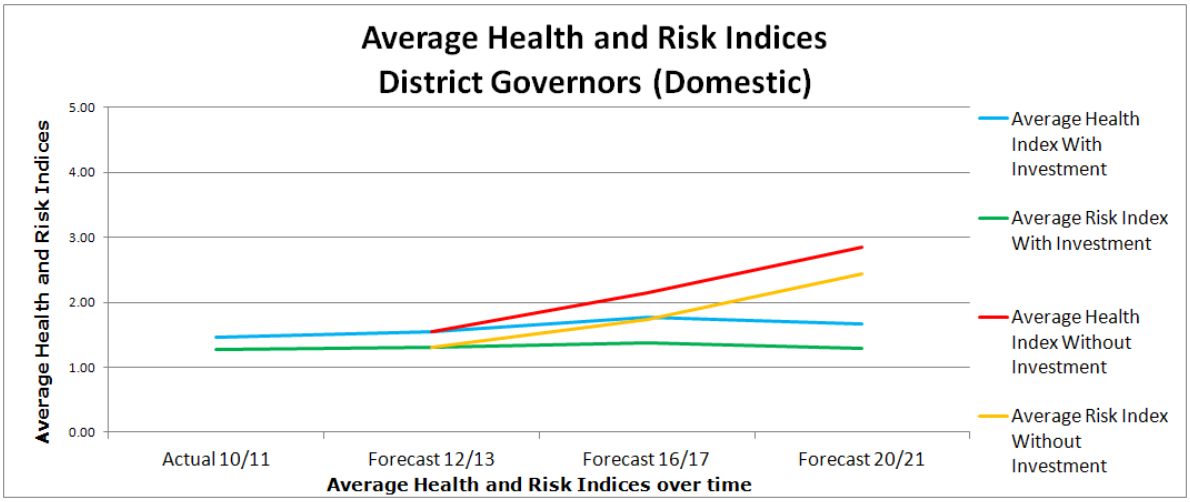
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 19.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- There are very few district governors in the highest three risk categories and our intervention is targeting at maintaining this.
- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn are aimed at maintaining our current performance on the two primary output categories.
- The average risk for Domestic District Governors is improved slightly as a result of the installation of 30 new District Governors feeding more than 20,000 consumers or more than 10,000 on a single source network.

Confidence level in this data

Good: uses a full Condition Based Risk Management model, including calculation of risk.

Appendix 23. I&C Governors

Asset Population

WWU has an estimated 3,877 Industrial & Commercial governors, 652 District which are in a CBRM model and 3,225 Service which use an exponential ageing curve.

Growth of Asset Population

The population only grows through installation of new sites where localised increase in demand occurs, such as new housing development.

Health Index

District Industrial & Commercial governors were surveyed during the summer 2010 for a range of data including condition, environment and duty. This survey data combined with asset data such as pressure range and faults is entered into the Condition Based Risk Management model to produce a Health Index score of 0.5 to 10.

Service Industrial & Commercial governors were sample surveyed during 2010/11 for a range of data including condition, environment and duty. This survey data combined with the age distribution of service inlet pipes has been to plot all assets on an exponential curve to produce a Health Index score of 0.5 to 10.

Ageing

The CBRM model has an ageing algorithm that forecasts the future Health Index score at each site in any given year. This algorithm has been produced in conjunction with an external asset management consultancy, who have had their assumptions verified by university research. The exponential curve used is based on the CBRM model.

Criticality

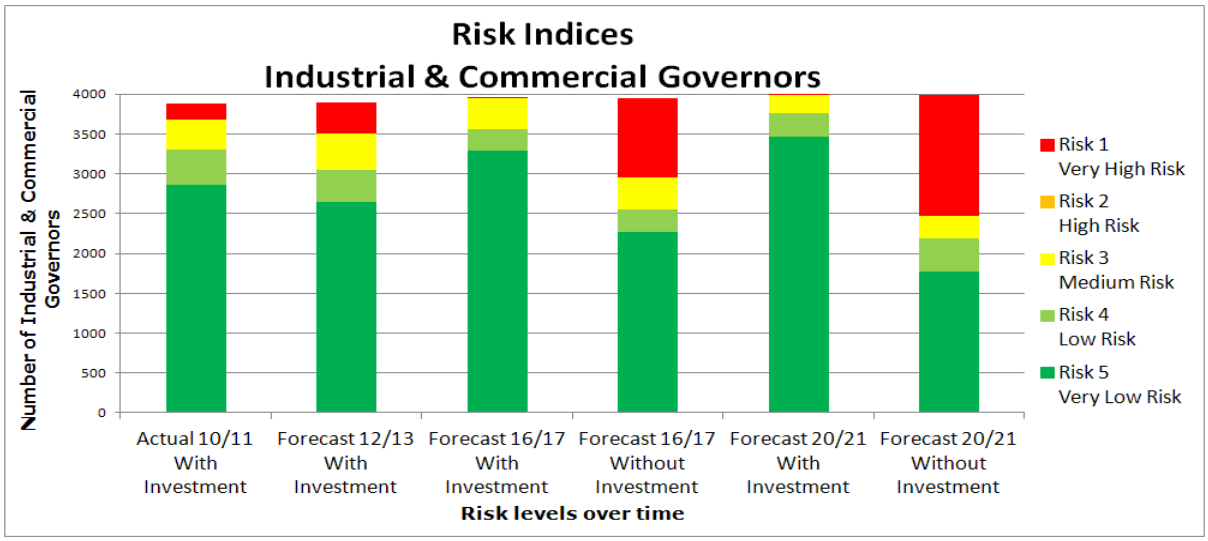
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. Industrial & Commercial governors are all low criticality assets.

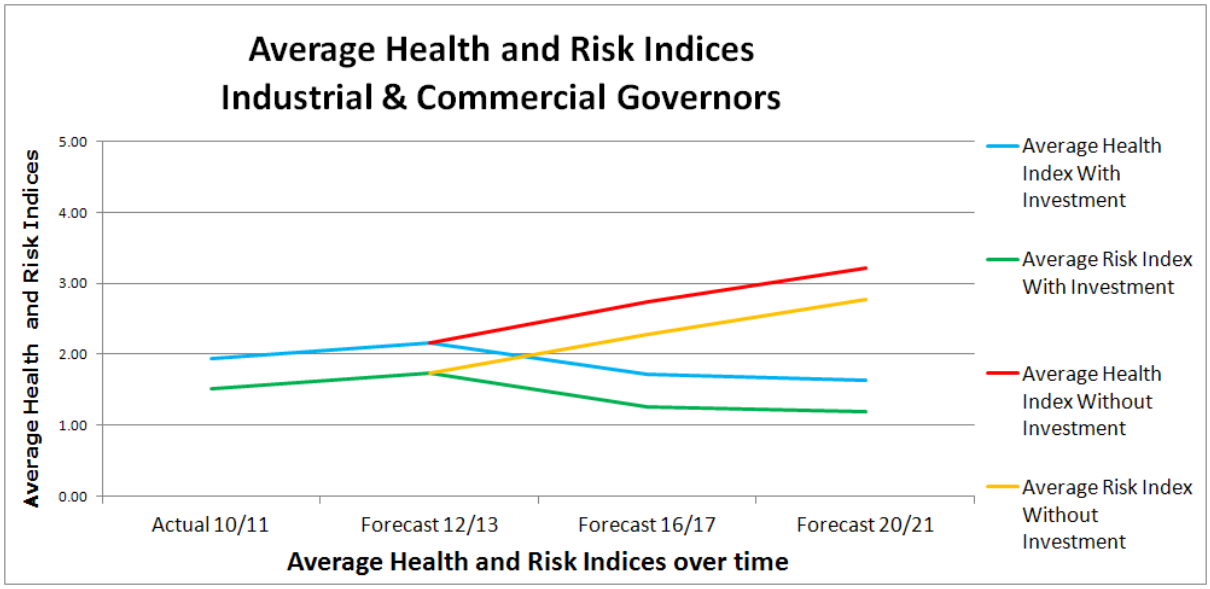
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 8.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn are aimed at maintaining our current performance on the two primary output categories. The slight improvement shown is to maintain compliance with relevant legislation.

Confidence level in this data

Very Low - Incomplete population data, no model and no condition data for majority of population.

Appendix 24. Service Governors

Asset Population

WWU has 14,022 Service Governors, with an estimated 10,797 feeding domestic premises and 3,225 feeding Industrial & Commercial premises.

Growth of Asset Population

The population only grows through installation of new sites where localised increase in demand occurs, such as new housing development.

Health Index

Service Governors were sample surveyed during 2010/11 for a range of data including condition, environment and duty. This survey data combined with the age distribution of service inlet pipes has been to plot all assets on an exponential curve to produce a Health Index score of 0.5 to 10.

Ageing

The exponential curve used is based on the CBRM model which has an ageing algorithm that forecasts the future Health Index score at each site in any given year. This algorithm has been produced in conjunction with an external asset management consultancy, who have had their assumptions verified by university research.

Criticality

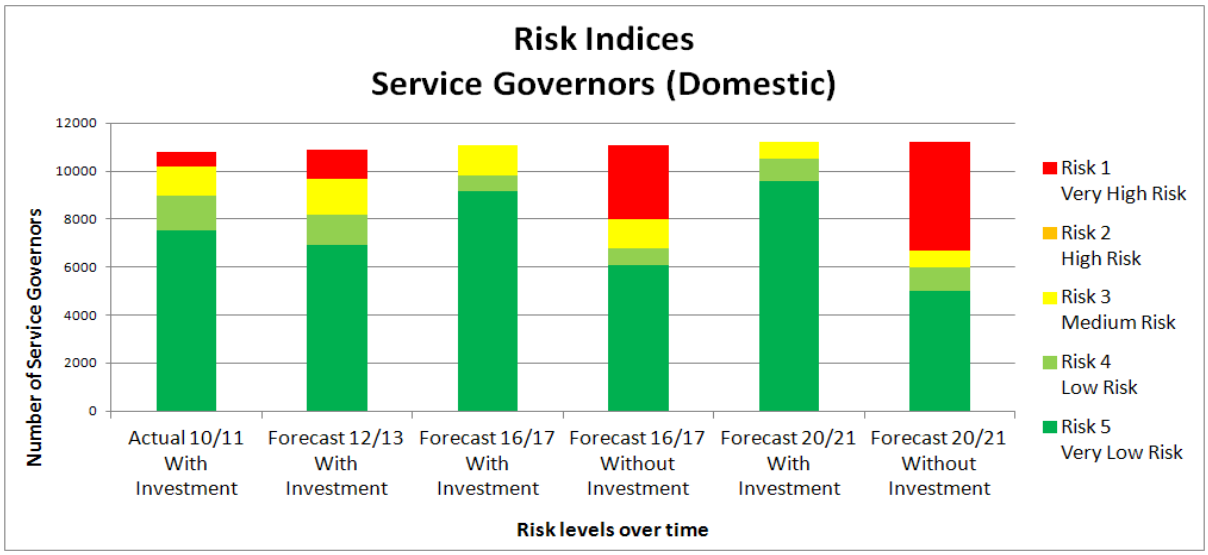
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. Service governors are all low criticality assets.

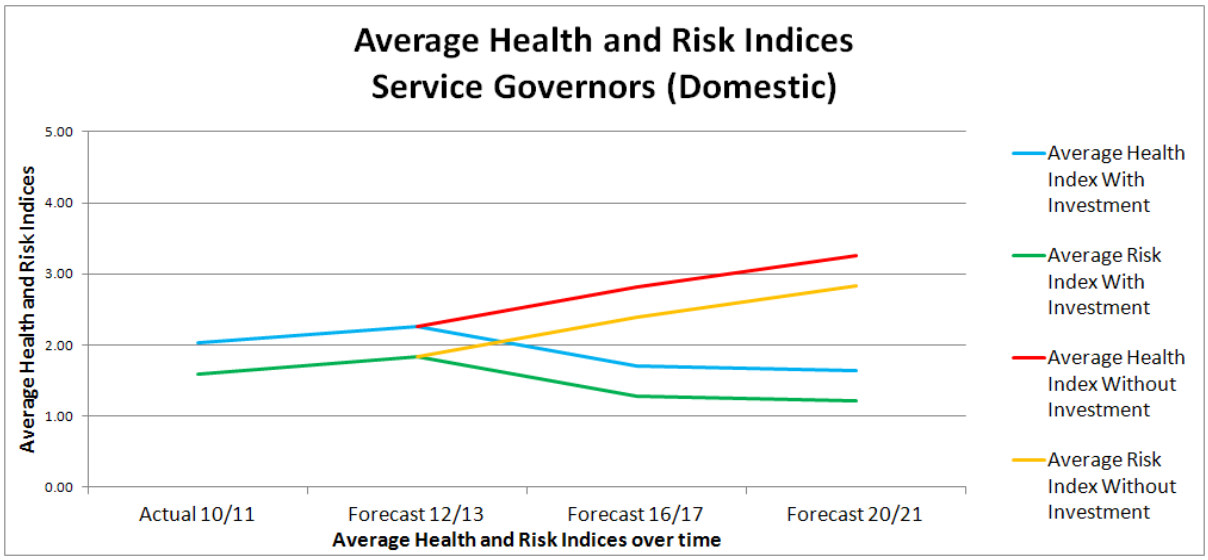
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 6 and a maximum total of 7.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	✓	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- There are very few governors in the highest three risk categories and our intervention is targeting at maintaining this.
- Without investment, both the health index and risk rise significantly which would not be an acceptable output position because stakeholders have indicated that current levels of reliability are required and we have legal obligations to maintain these assets.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions which in turn are aimed at maintaining our current performance on the two primary output categories. The slight improvement shown is to maintain compliance with relevant legislation.

Confidence level in this data

Very Low - Incomplete population data, no model and no condition data.

Appendix 25. Telemetry

Asset Population

WWU has telemetry assets in the following quantities; 1131 > 7bar, 3873 below 7bar, 18 storage. These are of a wide variety, for monitoring pipelines, storage, offtakes, Pressure Reduction Installations and Governors.

Growth of Asset Population

The above 7 bar and below 7 bar telemetry asset population increases over the period of assessment in line with investment forecasts.

The storage telemetry population diminishes over the period of assessment in line with holder de-commissioning.

Health Index

Health index for each asset group was assessed by expert opinion, using staff who are familiar with undertaking maintenance. This has lead to the use of a 6 to 10 year life range for telemetry assets, based essentially on the obsolescence of equipment with age.

Ageing

WWU have developed an in house ageing curve for these asset groups based on that used in the CBRM models developed for other asset groups. The curve uses the algorithm from the CBRM model and has been used to forecast the future Health Index per unit at any given year.

Criticality

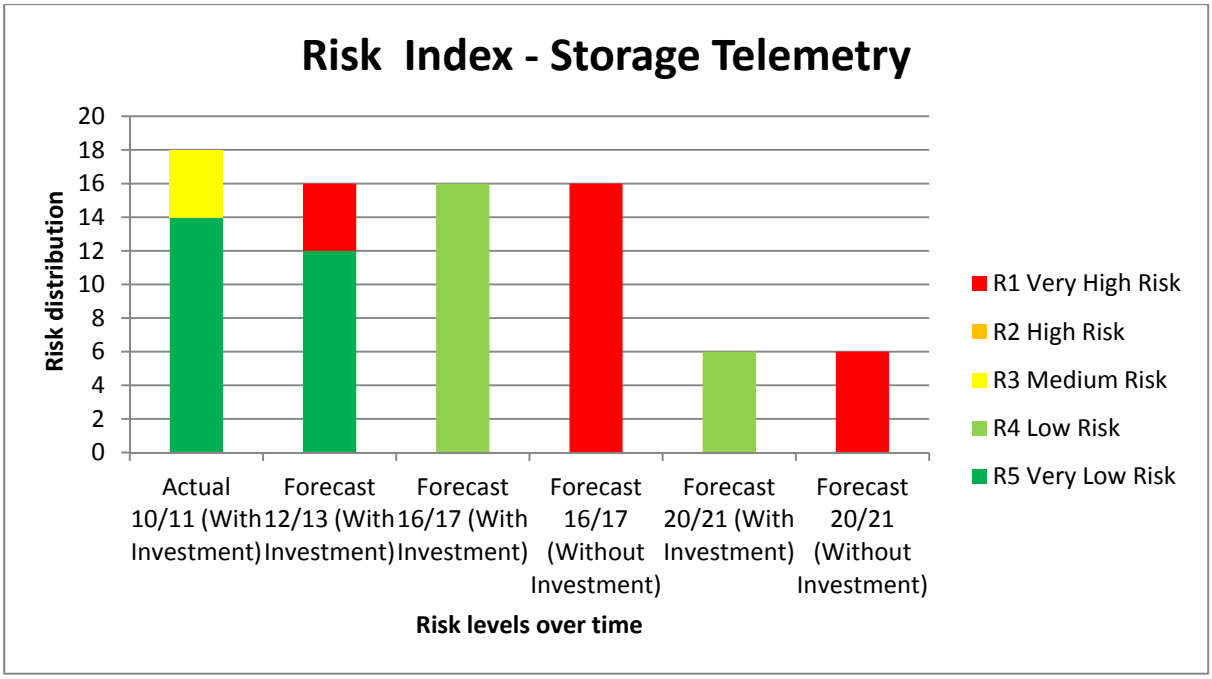
The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. Loss of Telemetry would not be immediately critical, because the items of equipment being monitored have their own fail safe systems to obviate pressure loss.

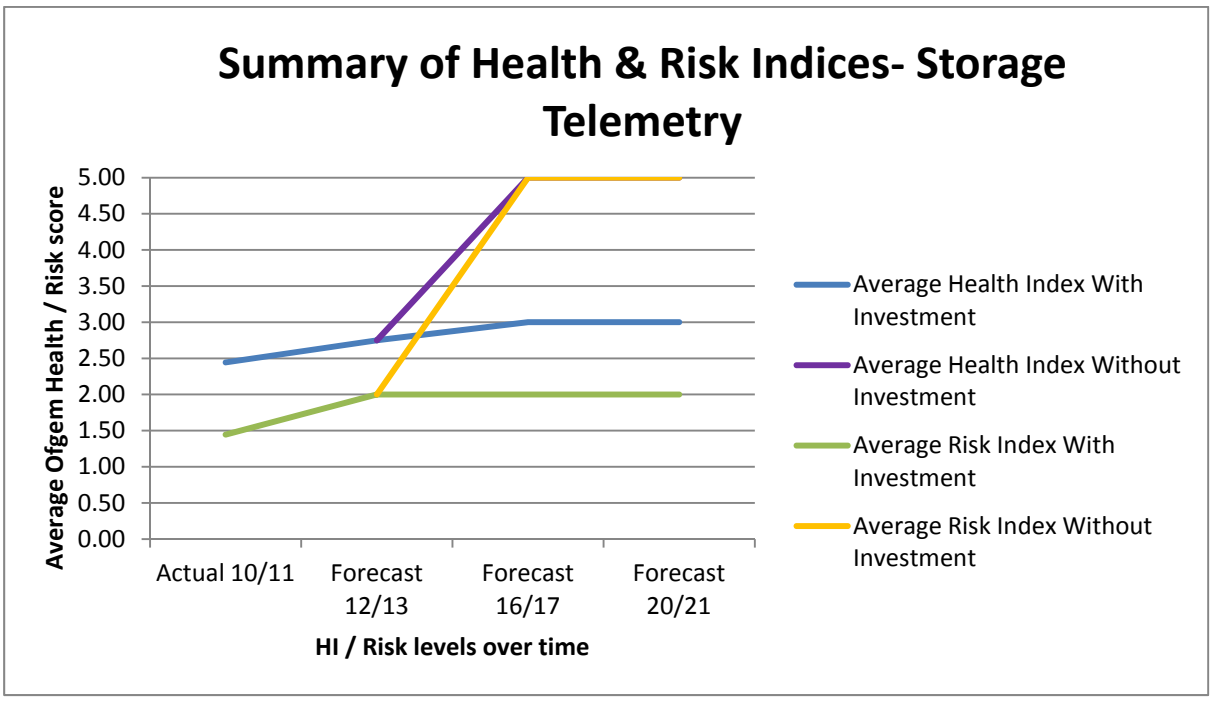
Consequence of Failure

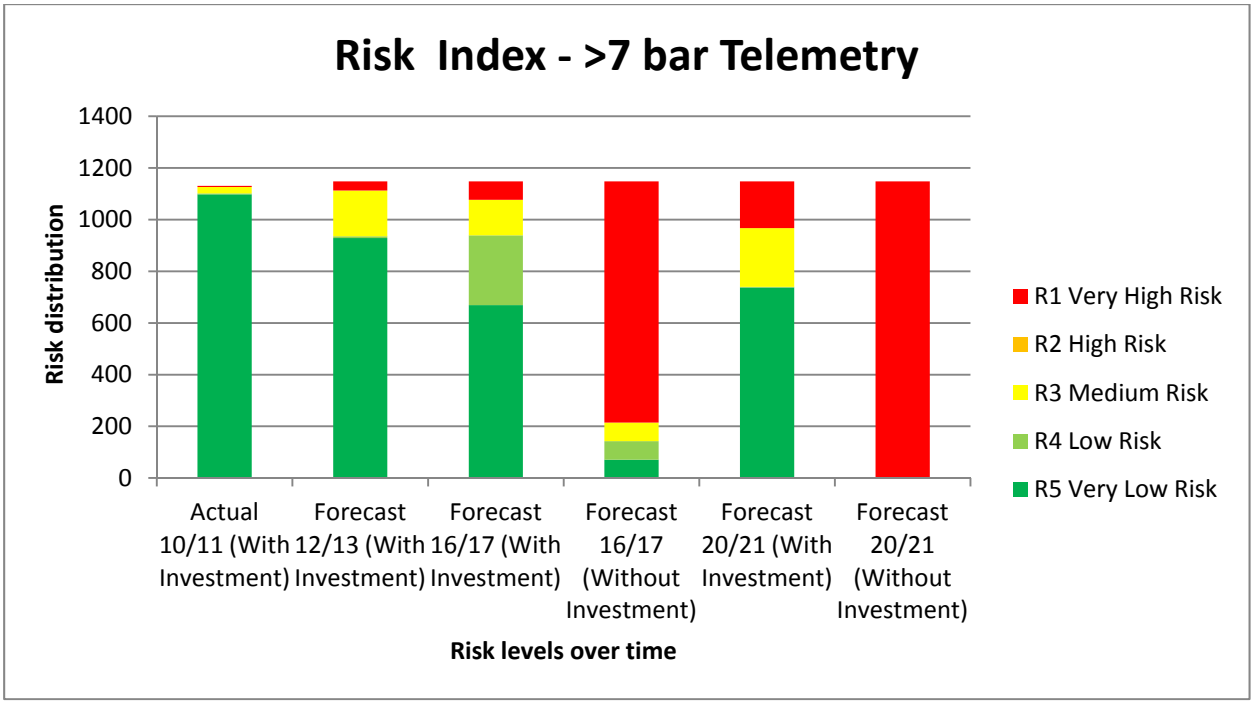
We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 4 and a maximum total of 4.

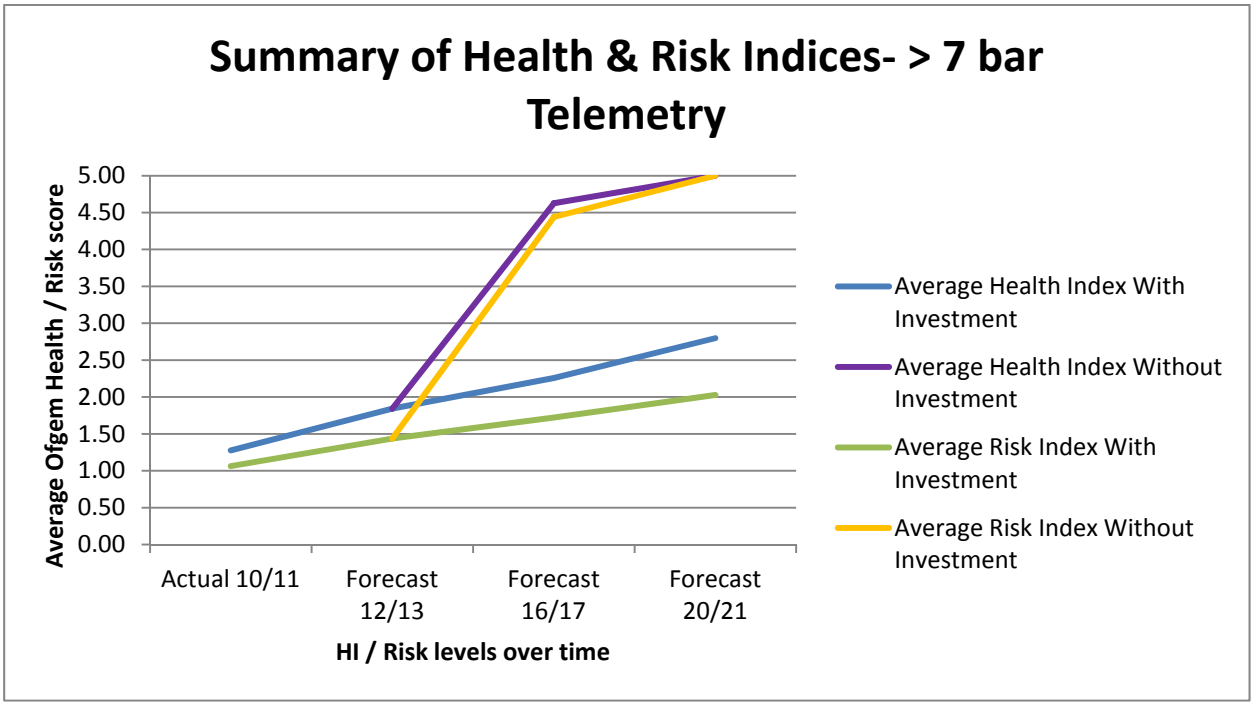
Category	Description	o Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	×	×	×	×
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

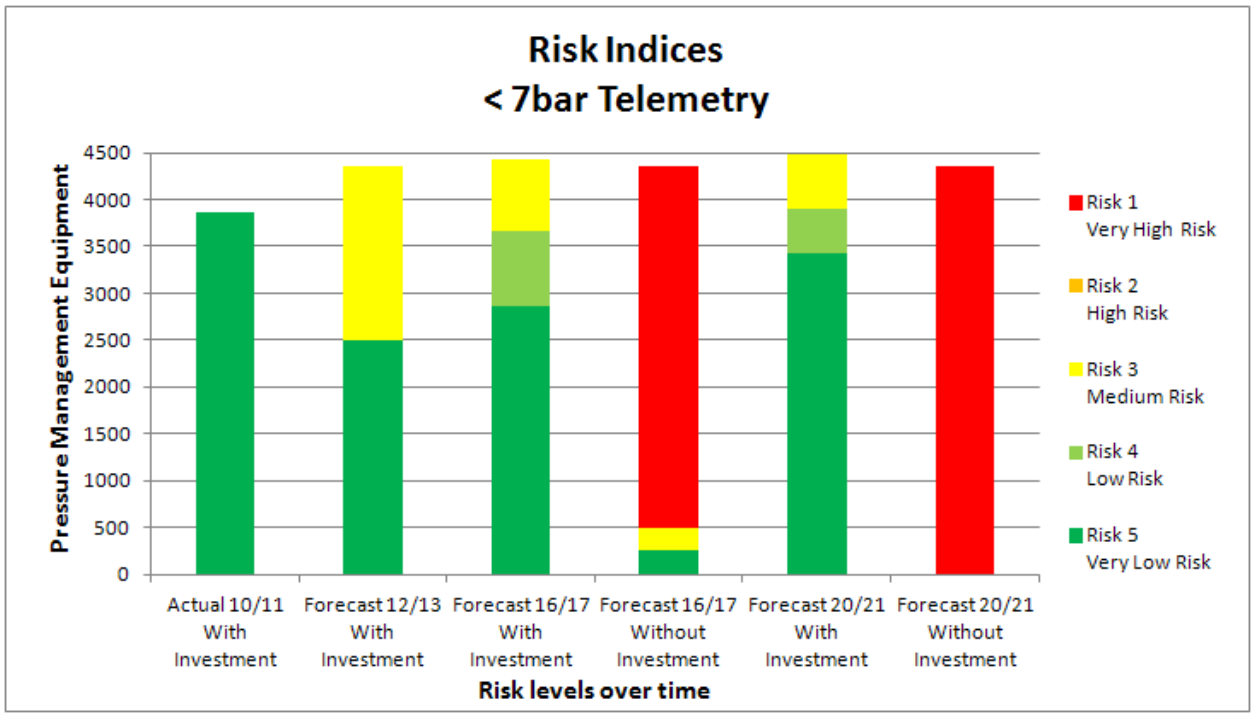
The resulting Health and Risk Indices over the period, with and without investment are as follows:-

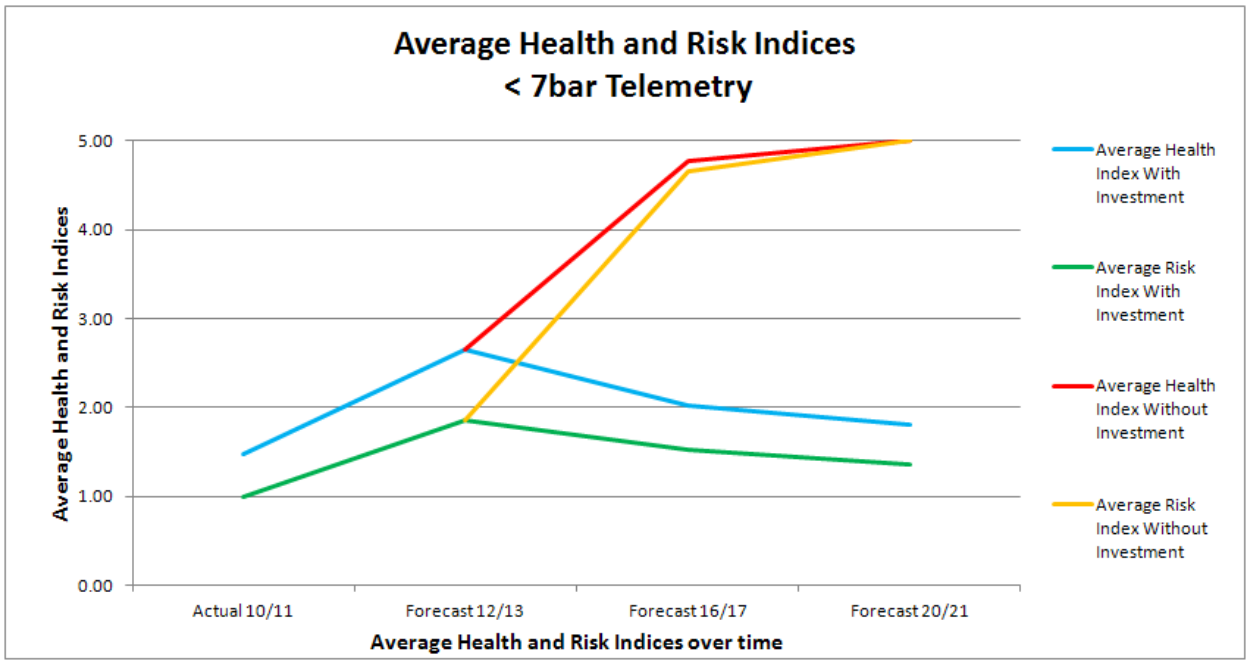

Risk Index - Storage Telemetry
Risk distribution
20
18
16
14
12
10
8
6
4
2
0
Actual 10/11 (With Investment)
Forecast 12/13 (With Investment)
Forecast 16/17 (With Investment)
Forecast 16/17 (Without Investment)
Forecast 20/21 (With Investment)
Forecast 20/21 (Without Investment)
Risk levels over time
R1 Very High Risk
R2 High Risk
R3 Medium Risk
R4 Low Risk
R5 Very Low Risk


Summary of Health & Risk Indices- Storage Telemetry
Average Ofgem Health / Risk score
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Actual 10/11
Forecast 12/13
Forecast 16/17
Forecast 20/21
HI / Risk levels over time
Average Health Index With Investment
Average Health Index Without Investment
Average Risk Index With Investment
Average Risk Index Without Investment


Risk Index - >7 bar Telemetry
Risk distribution
1400
1200
1000
800
600
400
200
0
Actual 10/11 (With Investment)
Forecast 12/13 (With Investment)
Forecast 16/17 (With Investment)
Forecast 16/17 (Without Investment)
Forecast 20/21 (With Investment)
Forecast 20/21 (Without Investment)
Risk levels over time
R1 Very High Risk
R2 High Risk
R3 Medium Risk
R4 Low Risk
R5 Very Low Risk


Summary of Health & Risk Indices- > 7 bar Telemetry
Average Ofgem Health / Risk score
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Actual 10/11
Forecast 12/13
Forecast 16/17
Forecast 20/21
HI / Risk levels over time
Average Health Index With Investment
Average Health Index Without Investment
Average Risk Index With Investment
Average Risk Index Without Investment





These graphs illustrate that:-

- The current condition of the population is generally good as there is a frequent replacement of these short life assets.
- Without investment, both the health index and risk rise dramatically which would not be an acceptable output position because stakeholders have indicated that current levels of reliability and environmental focus are required. This is due to the short asset life.

- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions; however the large variations between periods are a result of the cyclical nature of the investment due to the short expected life and the age profile of the population. The optimum investment is aimed at maintaining our current performance on the two primary output categories.

Confidence level in this data

Low: Known population but limited condition data and no model.

Appendix 26. LPG Storage

Asset Population

WWU has two Liquefied Petroleum Gas statutory undertakings. One at Llanfyllin is supplied by 12 Liquefied Petroleum Gas tanks across two sites and the other at Llawyrtydd Wells is supplied by 10 Liquefied Petroleum Gas tanks on a single site. For the purposes of categorising the Health Index of these assets all tanks on the same site will be classed as a single asset because they will have experienced the same deterioration mechanisms, operating conditions, maintenance and other condition related factors.

Growth of Asset Population

The tank farms at Llanfyllin (12 tanks over two sites) will be replaced in the final year of this current price control review period from 2008 to 2013 with a single tank farm (4 tanks) at a new site. Following this investment WWU forecast operation of these Liquefied Petroleum Gas tank farms will continue throughout the next period from 2013 to 2021. There are no plans for the decommissioning or installation of any further Liquefied Petroleum Gas tank farms. The population is therefore forecast to remain constant over the next price control period from 2013 to 2021.

Health Index

The health index for each Liquefied Petroleum Gas storage site is related to its age. The average life of a tank farm has been forecast as 40 years and the health index has been directly correlated to the age of the tank farm at that point in time.

Ageing

WWU has developed an in house ageing curve for these assets based on the ageing curve developed for the CBRM models for other asset groups. The curve uses the algorithm from the CBRM model and the average asset life defined for this asset group and can be used to forecast the future Health Index score for each site at any future year. The Liquefied Petroleum Gas tank farms have been aged based on the above methodology to establish their health indices at various stages over the next price control period.

Criticality

The term “criticality” is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, Liquefied Petroleum Gas tank farms have a range of criticalities in respect of the impact on downstream consumers, such as Number of Consumers fed, Location and Storage Capacity of the vessels.

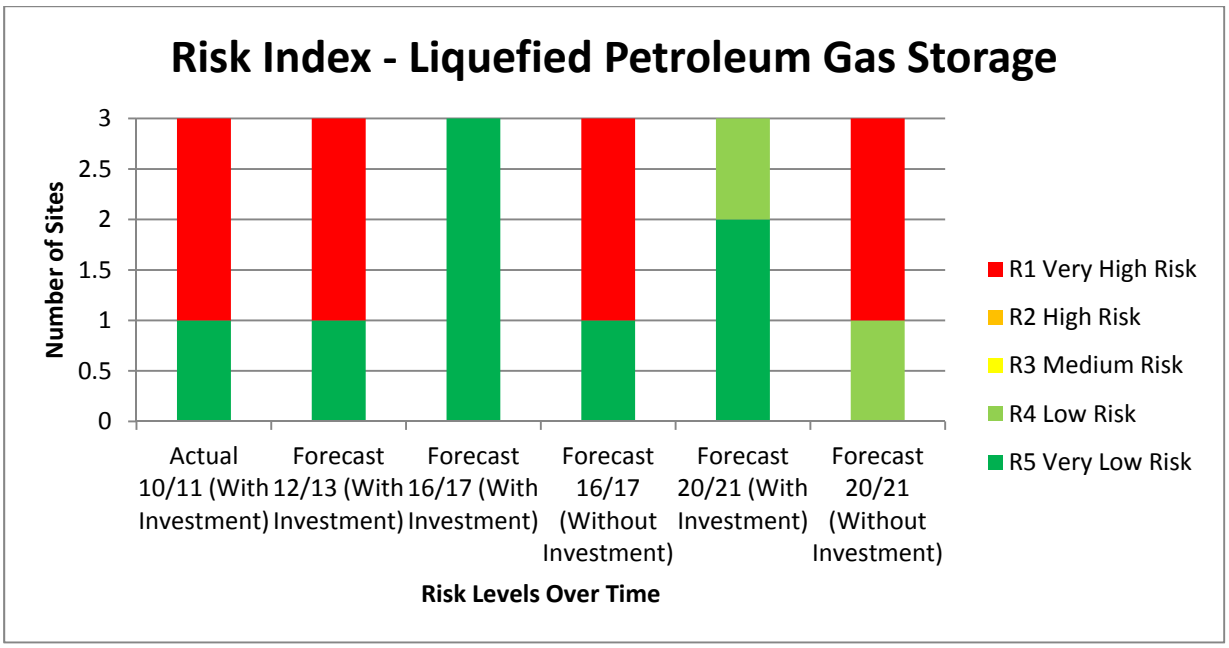
Consequence of Failure

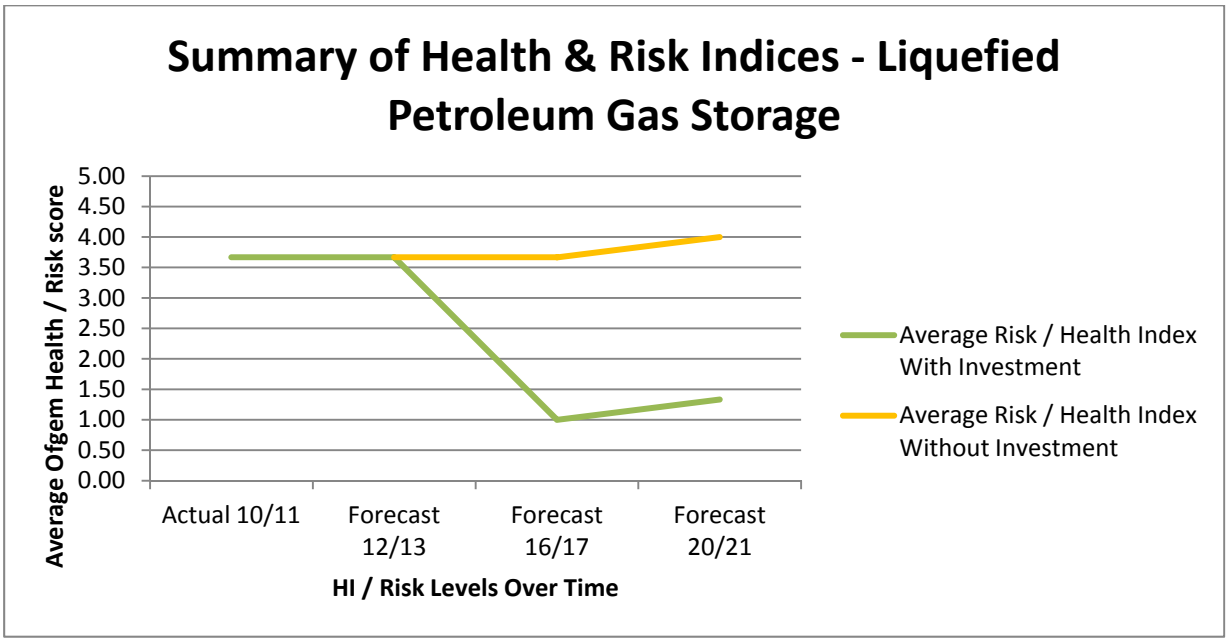
We have defined the worst credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 7 and a maximum total of 13:-

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	×	×	×	✓	×
Security of Supply	The cost to the consumer of being without gas	✓	✓	✓	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	✓	✓	✓

We have then assessed each asset in this asset group against this table, taking into account the specific parameters for each, to arrive at a total score specific to each asset in the group.

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk metric for Liquefied Petroleum Gas Storage remain high.
- Investment in the tank farm, which includes various types of intervention, results in an improvement in asset health indices and risk metrics. This is in accordance with stakeholder's reliability requirements. Simply maintaining health indices would not meet statutory requirements.

Confidence level in this data

Low: forecasts are based solely on age.

Appendix 27. LPG Mains

Asset Population

WWU has 8.2 km of Liquefied Petroleum Gas distribution mains and is not expected to change.

Health Index

The health index for Liquefied Petroleum Gas distribution mains is based on the material and age. For metallic mains, the health index is also determined through the condition score of the main. For example, new generation PE is HI1, whereas metallic pipes with a condition score greater than 0.5 are HI1.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and can be used to forecast the future Health Index totals at any given year for Liquefied Petroleum Gas distribution mains.

Criticality

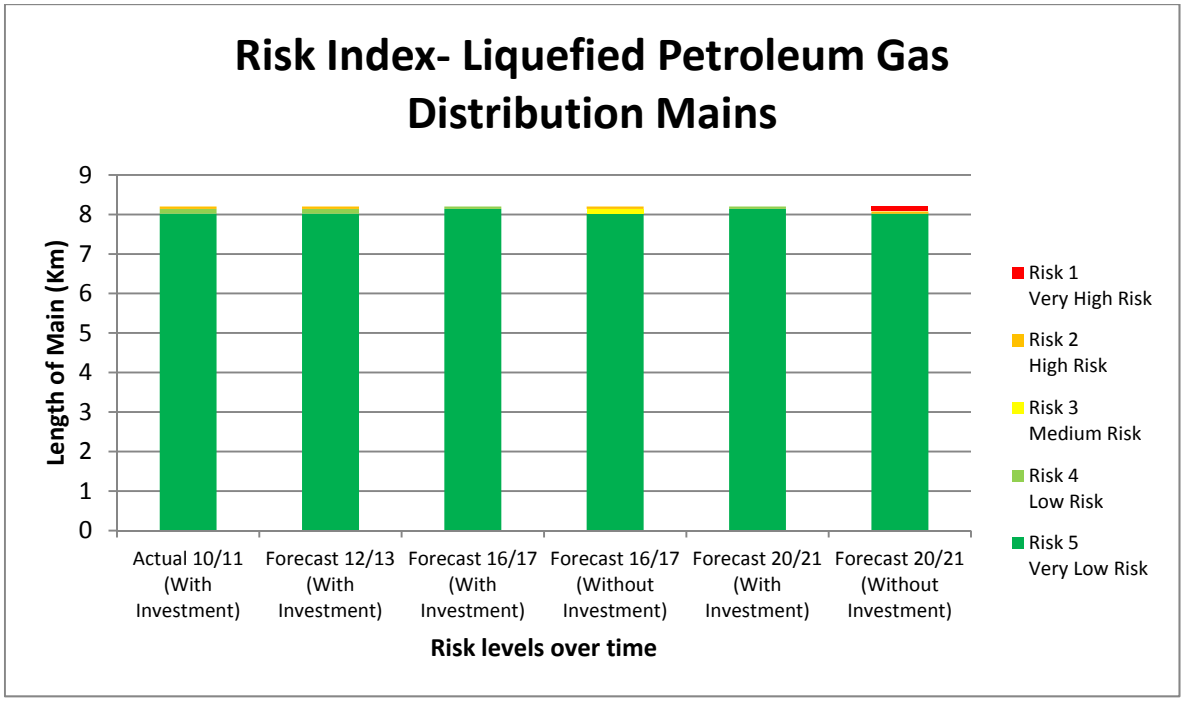
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for mains is a leak resulting in gas in buildings, leading to explosions.

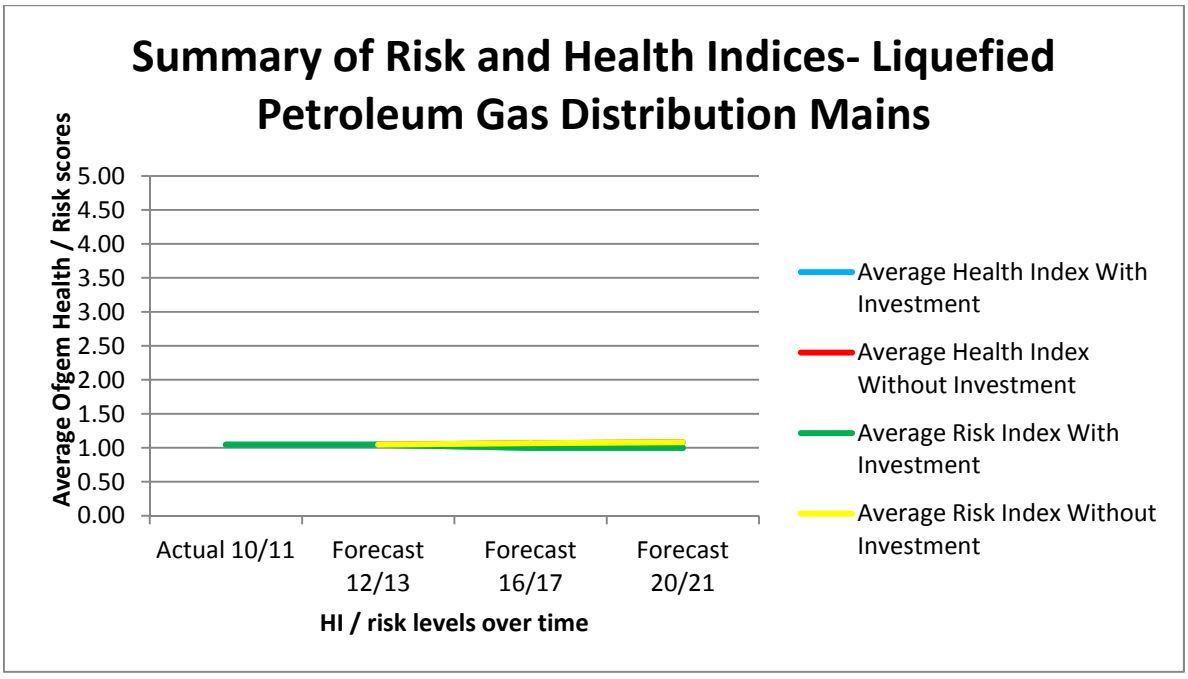
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 4 and a maximum total of 11.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	✓	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	✓	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	✓	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	✓	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise dramatically which would not be an acceptable output position, where stakeholders have indicated that increased levels of safety are required.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions.

Confidence level in this data

Medium: Known population but limited condition data and no model. However, failure data indicates condition to be good.

Appendix 28. Liquefied Petroleum Gas Services

Asset Population

WWU has 464 Liquefied Petroleum Gas services.

Growth of Asset Population

Any growth will be as a result of new connections.

Health Index

The health index for Liquefied Petroleum Gas services is based on the material and age. For steel services, the health index is also determined through postcode analysis. For example, PE with electro-fused joints is HI1, whereas steel pipes on postcode analysis are HI5.

Ageing

WWU have developed an in house ageing curve based on the work in the CBRM models. The curve uses the algorithm from the CBRM model and can be used to forecast the future Health Index totals at any given year for Liquefied Petroleum Gas services.

Criticality

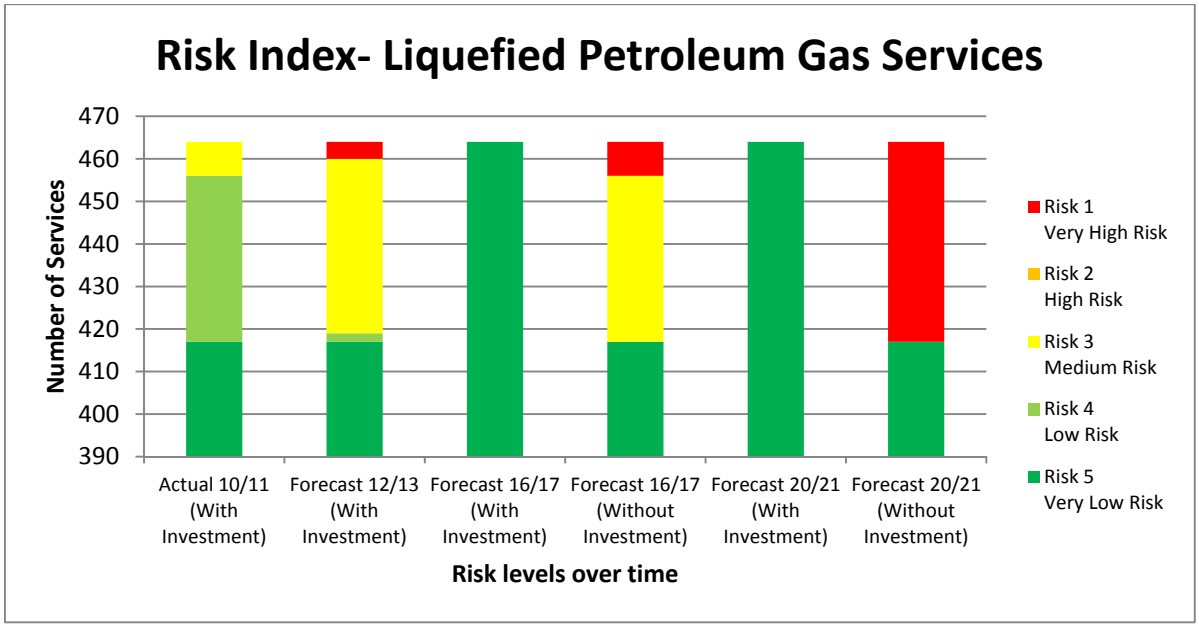
The term "criticality" is used by WWU to weight the consequence of failure of assets from a normalised viewpoint. For example, the worst consequence of failure for services is a leak resulting in gas in buildings, leading to explosions.

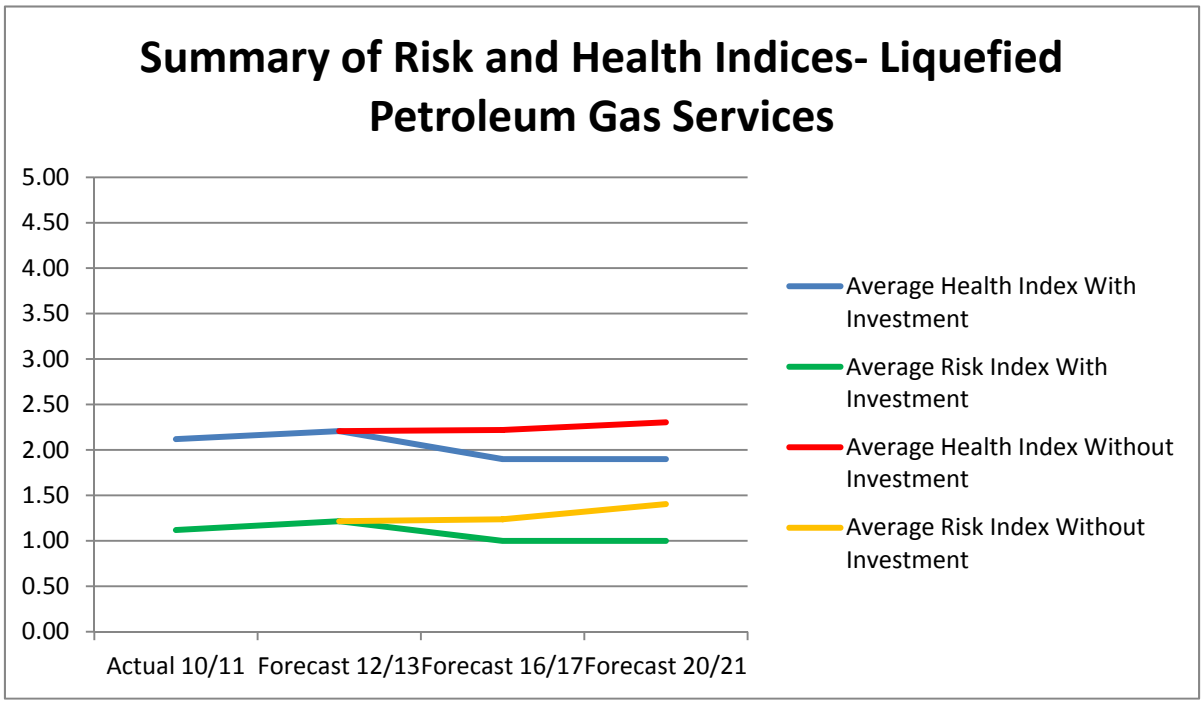
Consequence of Failure

We have defined the most significant credible failure mode for this asset group and then assessed the range of probable consequences (following table). The sum of the scores across the categories gives a minimum total of 4 and a maximum total of 8.

Category	Description	Available scores for this asset category				
		COF 1	COF 2	COF 3	COF 4	COF 5
Safety	The value of loss of life or injury	✓	✓	✓	✓	✓
Security of Supply	The cost to the consumer of being without gas	✓	×	×	n/a	n/a
Environmental	The cost to society of emissions from leaking gas	✓	×	×	n/a	n/a
Costs passed to the consumers	The cost of a failure for repair, restoration and compensation	✓	×	×	×	×

The resulting Health and Risk Indices over the period, with and without investment are as follows:-





These graphs illustrate that:-

- Without investment, both the health index and risk rise marginally which would not be an acceptable output position, where stakeholders have indicated that increased levels of safety are required.
- To satisfy stakeholder requirements, we are broadly maintaining asset health and risk indices with our proposed interventions.

Confidence level in this data

Medium: Known population but limited condition data and no model. However, failure data indicates that condition of PE services is good.