Appendix 14 – The link between leakage and bursts

Wessex Water

March 2019

Wessex Water
YTL GROUP

WESSEX WATER

Impact of Leakage Reduction on Burst Rate

WEW0028
Impact of Leakage Reduction on Burst Rate
02
28 February 2019

www.rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
1	Internal Draft	D Watts	P Dommett	[Text]	15/02/2019
2	Draft	D Watts	P Dommett	M Butler	28/02/2019
3	Final	D Watts	P Dommett	M Butler	14/03/2019

Prepared by:

RPS Environmental Management Ltd

Michael Butler
Technical Manager

Matford Business Park, 6 Manaton Court
Exeter, Devon EX2 8PF

T +44 1392 677 333
E michael.butler@rpsgroup.com

Prepared for:

Wessex Water

Martin Gans
Water Distribution Planning Manager

Claverton Down Road, Claverton Down
Bath, BA2 7WW

T +44 7909 688 292
E martin.gans@wessexwater.co.uk

Contents

1 INTRODUCTION ... 1
2 APPROACH ... 1
3 MAINS BURST DEFINITION ... 2
4 PERFORMANCE COMMITMENTS ... 3
5 LEAKAGE STRATEGY AND DEFINITIONS ... 5
5.1 Option ALC1 - Innovation and optimisation of existing Active Leakage Control ... 7
5.2 Option ALC2 - Increased Active Leakage Control activity ... 7
5.3 Option ALC3 – ALC Optimisation through better data ... 8
5.4 Options AM1a to AM1c: Leakage driven asset renewal ... 9
5.5 Options AM2 - Better DMAs ... 11
5.6 Options AM3 - Near real time monitoring and decision support ... 11
5.7 Options PM1 – Pressure Management Optimisation ... 12
6 UKWIR SUPPORTING RESEARCH ... 13
6.1 The Effects of ALC on Mains Bursts ... 13
6.2 The Effect of Pressure Management on Mains Bursts ... 14
6.3 The Effect of Mains Renewal on Mains Bursts ... 14
7 REVIEW OF WESSEX WATER DATA AND COMPARATIVE DATA FROM OTHER COMPANIES ... 15
8 PERFORMANCE FORECAST ... 18
8.1 Data analysis and statistics ... 18
8.2 Policy Assumptions ... 22
8.3 Forecast scenarios ... 25
9 SUMMARY AND CONCLUSIONS ... 30

1 INTRODUCTION

Wessex Water have engaged RPS to review their submitted performance commitment (network stability) considering their leakage reduction target increasing from 3% to 15% in AMP7.

In March 2018 Ofwat issued new reporting guidance on mains bursts/repairs (the terms are interchangeable) which is the same guidance as included in the March 2018 report for Ofwat and Water UK: "Targeted review of common performance commitments" and is almost the same as the historic JAR Table 11 mains bursts definition.

Ofwat has released an assessment of improvements to be made to Wessex Water's PR19 planning. This assessment includes a concern over Wessex Waters mains burst targeting, included below for reference.

Water mains bursts PC - Concern

The company states that the target will be difficult to achieve due to its active leakage control activity. The company does not provide sufficient evidence to justify this statement. This is relevant as the company's performance is relatively poor compared to median performance in the industry.

Water mains bursts PC - Required

The company should reconsider its proposed service levels and ensure that they are stretching. If the company continues to propose performance that is worse than its historical levels, it will need to provide compelling evidence that increased active leakage control impacts the total number of mains repairs using the company's own data, including the relationship between pro-active and reactive mains repairs. As a minimum the evidence should show the historical correlation between active leakage control, pro-active and reactive mains repairs. It should also show the impact of this relationship on forecast repair rates from the output of asset performance modelling. The company should also provide sufficient evidence to demonstrate that reduced (worse) performance levels are in the interests of customers and the assets.

This report aims to address this concern by reviewing and detailing the evidence behind the original PR19 submission and associated statements. RPS give consent for Wessex Water to reproduce this report for business planning purposes.

2 APPROACH

The approach taken has been to report on the following areas, with overarching conclusions summarised at the end of this document:

- A review of historic and future leakage and mains burst data provided by Wessex Water and other comparative information publicly available for other water companies.
- A review of data collated by Wessex Water from **PR19 Business Plan September 2018** tables Wn2 and Appointee 1.
- A review of all relevant UKWIR reports and draws conclusions on the relationship between leakage reduction and mains bursts.
- A high-level assessment of likely range of burst rates in AMP7 and beyond, based on the 15% leakage reduction in AMP7 and further leakage reduction thereafter.

Distribution leakage is assessed after customer losses have been deducted from total leakage. The 15% reduction in total leakage is to be achieved by combining a reduction of 10% in customer losses and a 16% reduction in distribution losses. This data is taken from the companies Water Resources Management Plan demand forecast and replicated in PR19 business plan table Wn2.

Customer Supply Pipe Losses (CSPL) does not account for any potential impacts arising from the increase in coverage of SMART metering. Reductions in customer losses are to be achieved through conventional metering, it is likely, however, that Wessex Water will benefit from an increased reduction in customer side leakage by increasing SMART metering penetration. However, Wessex Water will not be starting the transition to SMART metering until AMP8 at the earliest and therefore this is not relevant for the AMP7 forecast.

Table 2.1 below details Wessex Water's committed leakage targets for AMP7 for both customer side leakage and distribution side leakage.

	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Total	
Total Leakage – set from WRMP Ml/d.	78.16	75.81	73.47	71.12	68.78	66.43	11.7	15%
Customer Losses – set from WRMP Ml/d	11.97	11.70	11.43	11.17	10.93	10.74	1.2	10%
Distribution losses – calculated from above Ml/d	66.19	64.11	62.04	59.95	57.85	55.70	10.5	16%
Distribution losses – reduction required		2.1	4.2	6.2	8.3	10.5		

Table 2.1 Wessex Water AMP7 leakage targets

3 MAINS BURST DEFINITION

Wessex Water exactly follow the common definition of mains bursts which is as follows:

Mains bursts include all physical repair work to mains from which water is lost which is attributable to pipes, joints or joint material failures or movement, or caused or deemed to be caused by conditions or original pipe laying or subsequent changes in ground conditions (such as changes to a road formation, loading, etc. where the costs of repair cannot be recovered from a third party). Include ferrule failures that are attributable to mains material condition or local ground movements, but not incidents of ferrule failure due to ferrule materials, poor workmanship or associated with the communication pipe connection.

Incidents of over-pressure or pressure cycling, and surge failures etc. which reflect the system operating conditions, even where these failures are accidental rather than associated with weaknesses in pipe condition, are to be included.

For the avoidance of doubt, all leakage occurring at locations or through joint or material failures which would have been designed for the life of the main (irrespective of whether earlier failure occurs) should be regarded as mains bursts.

Failure of consumable or maintainable items (valve packings etc.) should be excluded along with valve, hydrant, washout and air-valve replacements. Any maintenance work on valve packings, hydrant seals, air valves etcetera, should also be excluded.

All third-party damage should be excluded where costs are potentially (rather than actually) recovered from a third party.

4 PERFORMANCE COMMITMENTS

Wessex Water has committed to reduce total leakage by 15% (11.8 Ml/d) in AMP7. Table 4.1 below details the yearly targets Wessex Water has committed to.

	Unit	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
In year target	Ml/d	78.2	75.8	73.5	71.1	68.8	66.4
% reduction – in year	%	0	3	6	9	12	15
PC – three-year average	Ml/d	78.9	77.6	75.8	73.5	71.1	68.8
% reduction – three-year average	%	0	1.6	3.9	6.9	9.9	12.8

Table 4.1 Wessex Water AMP7 leakage performance commitment

The follow is an extract for reference from Wessex Waters report **PR19 Appointee Table 1 Line R4 – Water mains bursts Methodology Statement:**

Past performance levels (where available)

Our current PC for the 2015/16 to 2019/20 period is < 1993 bursts per annum and uses the JAR Table 11 mains bursts definition as reported on discover water. The terminology of mains bursts may be replaced with mains repaired for PR19, this is a change of name only; we are still using the same JAR Table 11 definition.

Recorded data is show below.

Mains Bursts	2010/11	2011/12	2012/13	2013/14	2014/15
Recorded No.	1882	1751	1678	1778	1892
Length 31st March (km)	11509	11559	11610	11645	11688
Recorded rate /1000km	164	151	145	153	162

Table 4.2 Wessex Water historic burst rates

Our recorded data is taken from Table 11 reporting and forecast for the remainder of this AMP is shown below. The 1900 bursts forecast in 18/19 and 19/20 is based on the underlying trend with an allowance for the increased Active Leakage control needed to achieve our reducing leakage target.

Mains Bursts	2015/16	2016/17	2017/18	2018/19	2019/20
Recorded No.	1663	1863	1920	1900	1900
Length 31st March (km)	11762	11895	11935	11980	12025
Recorded rate /1000km	141	157	162	159	158

Table 4.3 Wessex Water PR14 burst rates

The forecast for mains length is calculated based on the average increase in mains length in a typical year from analysis of historical Table 11 data.

2020-25 Performance Commitment Levels

For the 2020/21 onwards, we will be using the same definition. We are retaining the existing definition and the existing penalty only level of < 1993 repairs per annum.

As leakage is driven down to lower levels then the number of detected repairs increases, and the number of reported leaks reduces. Overall as leakage is driven down lower we would expect the total number of mains repairs to increase slightly as we have seen some evidence of this in recent years. This is a complex issue, with significant uncertainty.

To account for an increased level of detected repairs because of the increase in Active Leakage Control (ALC) activity required to achieve lower leakage levels in the future it could be argued that the <1993 repairs per year target is revised upwards to account for this.

We have set the performance commitment level for the whole five-year period based on the <1993 bursts per year expressed as per 1000km year as shown below.

	2020/21	2021/22	2022/23	2023/24	2024/25
Target	<1993	<1993	<1993	<1993	<1993
Length 31st March (km)	12070	12115	12160	12205	12250
Target rate /1000km	<165	<164	<164	<163	<163

Table 4.4 High level mains burst performance commitment

Hence, we are expecting the number of bursts to increase due to reducing leakage, but we are proposing a reducing target, and hence we believe this is a stretching target as per the Ofwat methodology.

These numbers assume that our total mains length forecast continues at around the current rate.

Longer-term projection 2025 to 2040-45

Our long-term plan is to maintain stable asset health, and we have set the <163 bursts per year per 1000km in 2024/25 over the entire longer-term projection.

	2024/25	2029/30	2034/35	2039/40	2044/55
Target Rate	<163	<163	<163	<163	<163

Table 4.5 Wessex Water current long term burst rate targets

The number of bursts is expected to increase due to reducing leakage, but a reducing target has been proposed, and hence this is a stretching target as per the Ofwat methodology.

The following is a further extract from Wessex water's **PR19 Business Plan September 2018 Appendix 3.1.A – Performance commitment detail.**

7.4.2 Proposed level and outcome delivery incentives

Incentive type: Underperformance only.

Rationale for incentive type: ODI type prescribed by Ofwat as this is a common measure.

Proposed performance commitment level.

	Unit	2020-21	2021-22	2022-23	2023-24	2024-25
PC	Mains Bursts/1,000km	<165	<164	<164	<163	<163

Table 4.6 Wessex Water AMP7 burst targets

Rationale for level: Stable asset health.

Rationale for PC profile: The target is set to maintain stable asset health with each year's figures adjusted to reflect the forecast mains length.

	2045
Long-term ambition	<163

Table 4.7 Wessex Water long term burst target

Rationale for 2025-2045 forecast: To maintain stable asset health in the long term.

P10 and P90.

	Unit	2020-21	2021-22	2022-23	2023-24	2024-25
P10	No, / 1,000km	174	173	173	172	171
P90	No. / 1,000km	138	137	137	136	136

Table 4.8 Wessex Water P10 and P90

Rationale for P10: PC target plus 10%.
Rationale for P90: Best historical performance (2015-16).

5 LEAKAGE STRATEGY AND DEFINITIONS

Wessex Water engaged Serverlec Technologies to undertake their Sustainable Economic Level of Leakage (SELL) report ref: J6605\GD\012\04 which was published 02/01/2018. The following extract outlines the conclusions:

A point estimate for the SELL has been derived using the preferred Method A approach. A range for the SELL has been derived incorporating the findings of sensitivity analysis centred on the Method A result and the lower result from the Method B analysis with greater uncertainty.

SELL is significantly higher than current leakage levels. The results are summarised in Table 5.1.

Reporting Methodology	PR14 SELL (Ml/d)	PR 19 SELL (Ml/d)			Reported Leakage 2016/17 (Ml/d)
		Point Estimate	Range (Method A only)	Range (Method A and B)	
Current (TIF) Methodology	92	94.1	89.4 – 97.5	73.3 – 97.5	68.4
UKWIR (MLE) Methodology	n/a	104.4	99.4 – 107.5	83.3 – 107.5	78.3

Table 5.1 SELL Results Summary

Tables 5.2 and 5.3 below are an extract from Wessex Water's WRMP 19 Options Report which details the Leakage Reduction Options selected by Wessex Water together with their contribution to the AMP7 leakage reduction plan:

Option reference	Description
ALC1	Innovation and optimisation of existing Active Leakage Control (ALC)
ALC2	Increased Active Leakage Control activity
ALC3	ALC Optimisation through better data
PM1	Pressure management Optimisation
AM1	Leakage driven asset renewal
AM2	Better DMAs
AM3	Near real time monitoring and decision support

Table 5.2 Wessex Water WRMP 19 Leakage Reduction Options

Driver	Option	Description	Ml/d
Leakage	ALC1	Innovation and optimisation of existing Active Leakage Control	1
Leakage	ALC2a	Increased Active Leakage Control activity 2Ml/d	2
Leakage	ALC2b	Increased Active Leakage Control activity 1.5 of 5Ml/d	1.5
Leakage	ALC3	ALC Optimisation through better data	2
Leakage	AM2	Better DMAs	2
Leakage	PM1	Pressure Management Optimisation	2
Total			**10.5**

Table 5.3 Wessex Water AMP7 leakage reduction plan

Sections 5.1 to 5.6 below provide detailed descriptions of the Leakage Reduction Options detailed in Table 5.2 above, also extracted from the Wessex Water's WRMP 19 Options Report for reference.

5.1 Option ALC1 - Innovation and optimisation of existing Active Leakage Control

5.1.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous monitoring, pressure management, together with asset repair and replacement.

Our network is growing each year by around 5,000 new customers and 40km of new mains. This together with the ageing of our distribution network over time puts an upward pressure on leakage. Our business as usual approach has always included the adoption of new and innovative technology to improve the efficiency and effectiveness of our active leakage control policy, and continuous monitoring and pressure management to enable us to meet leakage targets at the least cost to our customers.

This option assumes 1 Ml/d reduction in distribution losses should be achievable in AMP7 with no increase in base operating total leakage expenditure based on our established track record of innovation and efficiency improvements. This will not be delivered by any one specific strategy, but rather by a number of small evolutionary improvements across our active leakage control, and continuous monitoring and pressure management activities.

It is assumed that WW will continue as a minimum with its current active leakage programme and the additional savings are assumed in the baseline WRMP.

5.1.2 Uncertainty and risk

There is significant uncertainty over a few factors affecting leakage volumes and leakage management total expenditure costs including:

- *Underlying deterioration of the pipe network*
- *Repair and maintenance costs increasing above the rate of inflation*
- *Higher expenditure needed to maintain leakage lower levels – having driven leakage down in AMP6 we need to spend more than to hold it down – the analogy being if you increase your speed on the motorway from 70mph to 80mph one needs to burn more fuel to maintain the higher speed*
- *Innovation and new technology can have uncertain benefits and cost*

This option is assed as low risk and uncertainties when compared to other options.

5.2 Option ALC2 - Increased Active Leakage Control activity

The options in this section are:

- *Option ALC2a - Additional active leakage control to save 2 Ml/day*
- *Option ALC2b - Additional active leakage control to save 5 Ml/day*

5.2.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous monitoring, pressure management, together with asset repair and replacement.

At present we have 73 active leakage staff made up of:

- *1 Regional Leakage Planning Manager*
- *1 Regional Active Leakage & Control Manager*
- *4 leakage engineers/supervisors*
- *3 Division leakage managers*
- *55 leakage inspectors and technicians*
- *1 pressure control manager*
- *8 pressure control technicians*

Our detection staff typically find 4,000 to 5,000 leaks every year. Our Natural Rate of Rise detected (NRRd) which is the amount leakage would increase if we did not undertake detection work is around 45Ml/d.

The options are based on employing more ALC staff who could carry out a period of increased leakage activity (the transition period) to drive leakage down to the target level followed by a continuous increase in activity would then be required to maintain the reduced leakage level.

ALC marginal cost curves have been derived to assess the impact of additional front-line staff on reducing leakage and the associated marginal cost of repairing more leaks more quickly.

5.2.2 Uncertainty and risk

This option is assed as low risk and uncertainties when compared to other options.

5.3 Option ALC3 – ALC Optimisation through better data

5.3.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous monitoring, pressure management, together with asset repair and replacement.

As part of our business as usual approach to adopting new and innovative technology to improve the efficiency and effectiveness of our leakage management we undertook a review in AMP6 of longer-term options which could be implemented in AMP7 and beyond. This started with an idea generation phase, followed by initial quantitate assessment. From this we indented the most beneficial option for a significant step forward in ALC optimisation.

This option differs from ALC1, which is just the gradual incremental optimisation of existing strategies. This option is defined as “a significant step forward” by adopting new technology and processes to fundamentally change the way we prioritise our ALC activity. Key elements of this option include the following.

5.3.2 Better understanding of background leakage

A more rigorous and detailed understanding of background leakage in DMAs is no small undertaking. It would require significant data cleansing and improvement and new analytical technique. However, the potential benefit of being to differentiate between uneconomic background leakage from leakage breakout which is cost effective to repair is significant.

5.3.3 DMA and pipe classification

Allied to the above is more rigorous and detailed understanding of DMA and pipe classification including not just asset type and age, ground conditions and surface loading, but also operating and transient pressures and pipe level deterioration modelling

5.3.4 Data analytics

A "big data" approach to analyse this data is also required to find any significant changes in the data suggesting leakage changes.

5.3.5 Data visualisation

Data visualisation in the field is key to delivering tangible benefits from this approach as it needs to enable front line staff on the ground to reduce the time to find the harder to find larger volume leaks in a dynamic and real time environment.

5.3.6 Uncertainty and risk

This option is assed as medium risk and uncertainties when compared to other options.

5.4 Options AM1a to AM1c: Leakage driven asset renewal

The options in this section are:

- *Option AM1a: Replacement of service pipes to save 2 Ml/day at lowest cost*
- *Option AM1b: Replacement of the next best service pipes to save a further 2 Ml/d*
- *Option AM1c: Replacement of the next best service pipes to save a further 5 Ml/d*

5.4.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous night flow monitoring, pressure management, and asset replacement as required to meet our performance commitments on leakage; as well as our other commitments on, supply interruptions, customer contacts about water quality and mains bursts.

We have investigated the benefits of more extensive leakage driven asset renewal strategies for distribution mains, communication pipes and customer supply pipes, and various combinations of these.

This analysis was based on looking at leakage at a DMA level, disaggregated between assets in proportion to the leak numbers and average flow rates for mains and supply pipe leaks, as determined as part of the calculations for the Natural Rate of Rise (NRR). From this information the costs and potential water savings in each DMA were determined, considering the effectiveness of renewal for each type of asset in terms of *the assumed proportion of leakage removed. The costs and leakage savings for each DMA were calculated and ranked by cost per unit leakage saved.*

Cost curves for three main approaches are presented in Figure 5.1 below, and as clearly shown, whole service pipe replacement is by far the most cost beneficial strategy.

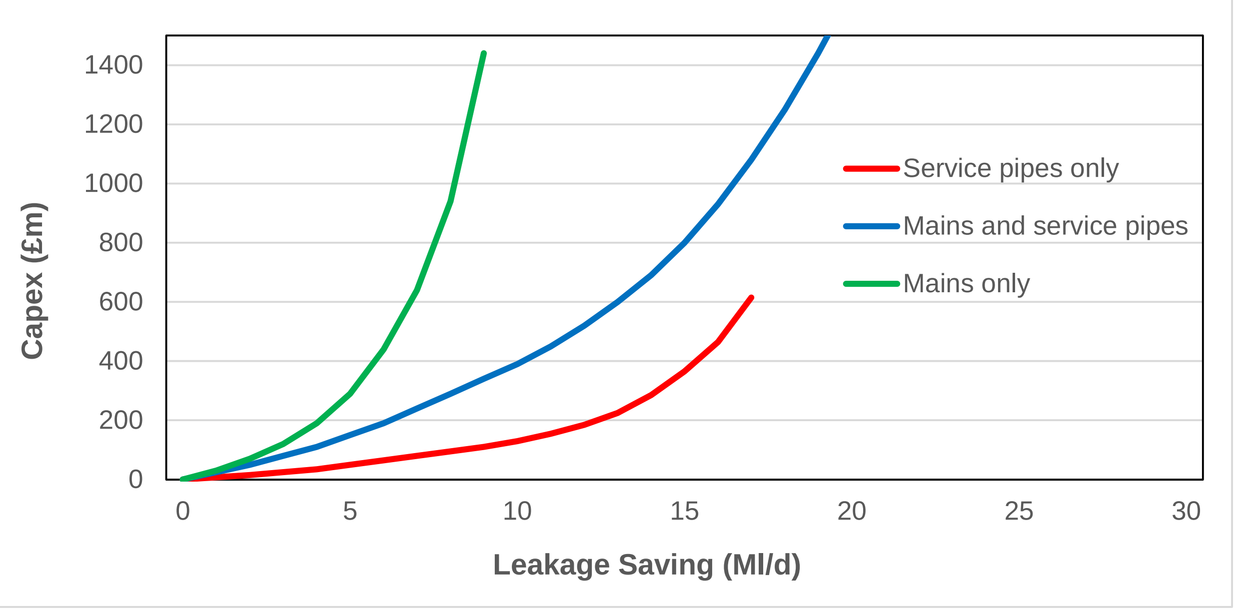

Figure 5.1 Leak driven asset renewal

5.4.2 Uncertainty and risk

The analysis produces the most likely outcome for each option based on current knowledge. The costs to achieve significant leakage reductions through asset renewal are high compared to other options.

The constraints on the option relate to the cost effectiveness of the replacement and the public tolerance for the extent of disruption demanded by a restrictive programme of construction.

The risks and uncertainties associated with this option are principally:

- *The relationship between asset renewal and savings in leakage, and hence the extent of renewal to achieve the target saving*
- *The NRR on the existing and renewed assets and its rate of change.*

Leakage options have been assessed in isolation and should be reviewed if they are to be implemented in conjunction with other options.

This option has relatively high risk and uncertainties when compared to some options.

5.5 Options AM2 - Better DMAs

5.5.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous monitoring, pressure management, together with asset repair and replacement.

The purpose of this option is to improve the efficiency and effectiveness of our ALC activity by optimising the size of the DMAs.

We have just over 600 fully functional DMAs within the Waternet analysis software. Of these, 67 have more than 2000 properties, and 56 have more than 40 km of mains. Analysis of these DMAs have identified 100 where it would be possible to subdivide in 200 DMAs without incurring excessive cost and where the background leakage and NRR data suggests the greatest leakage reduction benefits should be found.

The main benefit will be better night flow analysis, the ability to identify cost effective leakage breakout within smaller discrete areas which currently is masked by the larger night flows measured in these bigger DMAs.

The cost of DMA subdivision will comprise a combination of reconfiguration of pipework and valving, installation of new meters and PRVs, line valves and washouts at boundaries, and new continuous monitoring equipment.

Waternet has been used to analyse the leakage savings from these DMAs, calibrated against actual savings made in the past where DMAs have been subdivided.

5.5.2 Cost assumptions

The cost assumptions are that we have an initial capital expenditure over 2 years to create the new DMAs. This expenditure will include additional pipework, valves and DMA meters with the associated monitoring equipment. There is an ongoing Opex cost associated with monitoring the flow and pressure data along with maintaining the equipment. The result would be a better analysis of water loss resulting in additional and more timely repairs/ replacements reducing leakage.

5.5.3 Uncertainty and risk

There is significant uncertainty and risk associated with this option. Costs to subdivide these DMA may be considerably higher, or lower, than estimated, as only a desk top study have been completed. There is even more uncertainty over the leakage savings.

This option has relatively medium risk and uncertainties when compared to some options.

5.6 Options AM3 - Near real time monitoring and decision support

5.6.1 Scheme description

Our leakage management strategy is based on an active leakage control policy, with continuous monitoring, pressure management, together with asset repair and replacement.

Over the last 20 years our continuous monitoring strategy has developed from DMA meters with loggers manually downloaded once a month by someone visiting each site, to loggers s which transfer data weekly via SMS, to loggers transmitting data every 15 minutes via GPRS. During this time the number of flow and pressure data points sending back data has also increased.

However, it is only relatively recently that software systems have been introduced that allow more sophisticated "big data" analytics, and this market is still in its infancy. The ability to use the data is also hampered by IT infrastructure constraints, and more significantly a lack of decision support tools (and the corporatized network knowledge on which they are predicated), and the data visualisation needed to deliver the potential benefits from near real time monitoring.

It is anticipated that this is an area that will undergo significant innovation over the next 15 years, with new technology not currently visible on the horizon further increasing the benefits in the longer term.

However, the option is based on likely costs and benefits for systems that can be delivered within the AMP7 timeframe including but not necessarily limited to: more meters, more pressure points, more acoustic points, IT data infrastructure, big data analytics, knowledge management, decision support and data visualisation.

5.6.2 Uncertainty and risk

This option has relatively high risk and uncertainties across the board: costs, benefits, deliverability.

5.7 Options PM1 – Pressure Management Optimisation

5.7.1 Scheme description

Our business as usual approach has always included the adoption of new and innovative technology to improve the efficiency and effectiveness of our active leakage control policy, and continuous monitoring and pressure management to enable us to meet leakage targets at the least cost to our customers.

At present we have just under 1000 active pressure management areas, with around 1300 PRVs of which around 200 are standby. We have a mix of fixed outlet and modulated controllers. We have done significant work to optimise our pressure management over the last three years including ensuring every pressure managed area has a 15 minute transmitting critical point monitor, and upgrading 200 controllers to the latest specification. In addition, we created four new positions in our pressure management team, 2 new PRV maintenance technicians, a pressure management coordinator and data technician role with the intention of ensuring our existing pressure management was maintained close to the optimal 24/7/365. This is based on the minimum possible pressure at the critical point to avoid unwanted customer contacts about low pressure, which is usually around 20m.

This option is based on further optimisation of existing pressure management as above with the possible inclusion of closed loop control together with new installations, often tackling small areas without active pressure control or dividing existing PMAs into smaller units for better optimisation.

Supply network pressure is linked to leakage / burst occurrence. We have been introducing calm network operation training for field personnel and have been carrying out small scale transient monitoring assessments. Implementing a full pressure transient monitoring and resolution strategy would contribute to a reduction of leakage reoccurrence.

In addition, this option includes some trunk main pressure management which has not been explored in the past due to the higher complexity and difficulty in implementation but should provide some further leakage benefits.

5.7.2 Uncertainty and risk

There is some uncertainty over both the reduction in average and night pressures, and the reduction in leakage that will be achieved but this option is assed as low risk and uncertainties when compared to other options.

6 UKWIR SUPPORTING RESEARCH

There have been numerous UKWIR research projects undertaken which have centred around the relationship between ALC effort, leakage levels and leak repair numbers.

6.1 The Effects of ALC on Mains Bursts

Details relevant to Wessex Water's planned ALC policies are summarised below, with respect to previous studies on the relationship between burst rates and ALC. Each report found that changes in leakage and numbers of bursts were both influenced by the overall leakage effort.

6.1.1 Effect of Weather on Leakage and Bursts[1]

This report evidences that there is an inter relationship between changes in leakage levels and burst numbers.

6.1.2 Best Practice for the Derivation of Cost Curves in Economic Level of Leakage Analysis[2]

This reports evidences that increasing levels of ALC will result in a reduction of reported bursts as they become 'detected' in a more timely manner and do not increase in growth and develop into a 'reported burst'. As leakage levels reduce and reported bursts reduce, there is a requirement to locate and repair more leaks for the same volume of water.

6.1.3 Factors Affecting the Natural Rate of Rise of Leakage[3]

This report evidenced that there is a relationship between repair numbers and the natural rate of rise of leakage (NRR). This is supported by the T4 function: NRRt (m^3/d) = $a . L^{1.2} . A^{0.8} + b . (N.P)^{0.6} + c . tJ$

Where:

'a', 'b' and 'c' are coefficients from the regression.

[1] (2013) Effect of Weather on Leakage and Bursts – UKWIR 13/WM/08/50

[2] (2011) Best Practice for the Derivation of Cost Curves in Economic Level of Leakage Analysis – UKWIR 11/WM/08/46

[3] (2008) Factors Affecting the Natural Rate of Rise of Leakage – UKWIR 09/WM/08/40

L = DMA mains length (km)
A = Average DMA age by mains length (yrs)
N = Number of properties in DMA (nr.)
P = DMA average zonal night pressure (m)
tJ = total leak repair numbers

6.2 The Effect of Pressure Management on Mains Bursts

The following report summarising the current level of understanding between network pressure and burst frequency:

6.2.1 The Effect of Pressure Reduction on Burst Frequency[4]

This report determines that pressure management will realise a reduction in the number of repairs following implementation of schemes. It provides benefits in leak breakout rates and can aid in reducing the rate of deterioration of pipes within a network.

There was a correlation between the numbers mains repairs pre- and post- pressure management scheme implementations with a greater reduction being realised where pre- numbers are high.

6.3 The Effect of Mains Renewal on Mains Bursts

The following information from relevant UKWIR reports details the effect renewal activities are expected to have on repair number and the assumptions around this.

6.3.1 The Impact of Burst-Driven Mains Renewals on Network Leakage Performance[5]

This report mainly focusses on the impact of Mains renewal. On the whole results suggest an immediate reduction to leakage in the range of 8% to 15% over the 5 years post-completion of burst-driven mains renewal. A clear link was also apparent for repair numbers on renewed sections of mains. Patterns in leak repair numbers suggest that much of the benefits to leakage and NRR is a result of reduced mains repair requirements.

[4] (2012) The Effect of Pressure Reduction on Burst Frequency – UKWIR 12/WM/04/8

[5] (2018) The Impact of Burst-Driven Mains Renewals on Network Leakage Performance – UKWIR 18/WM/08/67

7 REVIEW OF WESSEX WATER DATA AND COMPARATIVE DATA FROM OTHER COMPANIES

RPS has assessed the UK water industry expectations of the influence that the new leakage reduction targets will have on burst frequency. Figure 7.1 shows the historic and forecast burst frequencies of the UK water companies, with values provided in Table 7.1.

For the historic data, it was noted that the burst rates across companies follow a similar pattern year-on-year, with highs and lows generally occurring in the same years on the whole.

Table 7.1 provides the predicted reductions in burst rates, including the percentage reduction to be achieved in AMP7. Predictions vary widely between companies. This suggests uncertainty within the water industry of how the burst rate is to be affected by the leakage reduction, with no real consensus on the effect of leakage reduction on burst rate. Several companies have assumed a constant burst rate target over the period.

Severn Trent Water and United Utilities are expecting a step increase for the first year, then a constant over the period. Southern Water, Yorkshire Water, and others to a lesser extent are expecting a constant decrease over the period, whereas Bristol and Hafren Dyfrdwy expect a step decrease. It remains unclear whether these changes have considered the leakage change, or if they have based their burst rate predictions on other factors during this period.

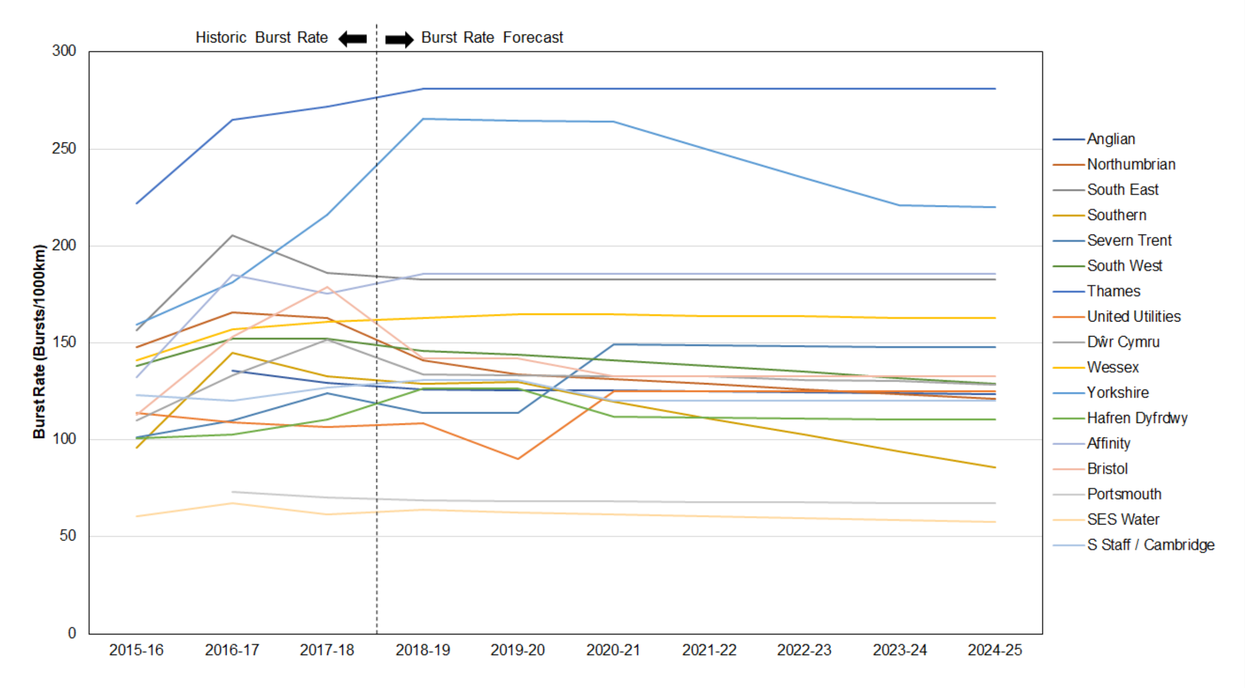

Figure 7.1 Historical and predictive burst rates for UK water companies

Company	Historical Burst Rate (Bursts/1000km)			Predictive Burst Rate (Bursts/1000km)							
	2015-16	2016-17	2017-18	2018 -19	2019 -20	2020 -21	2021 -22	2022 -23	2023 -24	2024 -25	AMP 7 %Red
Anglian		136	129	126	126	125	125	124	124	124	2%
Northumbrian	148	166	163	141	134	131	129	126	124	121	10%
South East	156	206	186	183	183	183	183	183	183	183	0%
Southern	96	145	133	129	130	120	111	103	94	86	34%
Severn Trent	101	110	124	114	114	149	149	148	148	148	-30%
South West	138	152	152	146	144	141	138	135	132	129	10%
Thames	222	265	272	281	281	281	281	281	281	281	0%
United Utilities	114	109	107	109	90	125	125	125	125	125	-38%
Dŵr Cymru	110	134	152	134	133	133	133	131	131	128	4%
Wessex	141	157	161	163	165	165	164	164	163	163	1%
Yorkshire	159	181	216	266	265	264	250	235	221	220	17%
Hafren Dyfrdwy	101	103	110	127	126	112	112	111	111	110	13%
Affinity	133	185	175	186	186	186	186	186	186	186	0%
Bristol	113	153	179	142	142	133	133	133	133	133	6%
Portsmouth		73	70	69	69	68	68	68	68	67	2%
SES Water	61	67	62	64	63	62	61	60	59	58	8%
S Staff / Cambridge	123	120	127	131	131	120	120	120	120	120	8%

Table 7.1 Historical and predictive comparisons of burst rates (bursts/1000km) for UK companies

Table 7.1 below shows the leakage performance commitments for AMP7 from several UK companies. Most of these companies are close or equal to the 15% industry wide challenge, with the notable exceptions of Yorkshire (25%) and South Staffordshire Water (23%).

Leakage from	2019/20					2024/25					Ml/d
Wn2 & WS3	Ml/d	Props	Km	l/prop/d	m3/km/d	Ml/d	Props	Km	l/prop/d	m3/km/d	%Red
Anglian	172	2,238	38,853	77	4.4	142	2,416	40,161	59	3.5	**17%**
Northumbrian	201	2,061	26,132	98	7.7	169	2,145	26,821	79	6.3	**16%**
South East	88	1,027	14,841	85	5.9	75	1,079	15,383	70	4.9	**14%**
Southern	105	1,129	13,975	93	7.5	90	1,194	14,185	75	6.3	**15%**
Severn Trent	422	3,656	46,778	115	9.0	357	3,768	47,373	95	7.5	**15%**
South West	116	1,064	18,337	109	6.3	100	1,110	18,592	90	5.4	**14%**
Thames	638	4,047	32,089	158	19.9	540	4,263	32,738	127	16.5	**15%**
United Utilities	448	3,354	42,376	134	10.6	381	3,476	42,842	110	8.9	**15%**
Dŵr Cymru	169	1,447	27,786	117	6.1	143	1,493	28,037	96	5.1	**15%**
Wessex	78	630	12,025	124	6.5	66	660	12,250	101	5.4	**15%**
Yorkshire	235	2,325	31,893	101	7.4	175	2,429	32,436	72	5.4	**25%**
Hafren Dyfrdwy	13	106	2,648	118	4.7	11	110	2,702	97	4.0	**15%**
Affinity	162	1,472	16,758	110	9.7	138	1,553	16,958	89	8.1	**15%**
Bristol	43	548	6,880	78	6.3	37	577	7,010	63	5.2	**15%**
Portsmouth	35	325	3,357	107	10.4	30	335	3,416	88	8.7	**15%**
SES Water	24	297	3,504	81	6.8	20	308	3,544	66	5.8	**15%**
S Staff / Cambridge	84	754	8,652	111	9.7	64	795	9,016	81	7.1	**23%**

Table 7.1 Leakage performance commitments of UK water companies

Table 7.2 below shows Wessex Water's forecast growth in properties assumptions for the AMP7 period. It is notable that the total connected properties rise from 629,671 to 660,203 over the period, a 4.8% increase. In is unknown what effect this increase in properties would likely have on the burst rate of the system. Similarly, network mains length is forecast to increase by 45 km/yr as summarised in table 7.4 below

WS3 - Wholesale water properties and population

	Line description	Item reference	Units	DPs	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
1	Residential properties billed for measured water (external meter)	BN2110	000	3	325.977	342.421	358.316	373.272	386.955	399.668	411.586	422.672
2	Residential properties billed for measured water (not external meter)	BN2115	000	3	26.205	28.158	29.548	30.937	32.327	33.717	35.107	36.497
3	Business properties billed measured water	BN2210	000	3	42.870	42.878	42.879	42.873	42.862	42.844	42.820	42.791
4	Residential properties billed for unmeasured water	BN2100	000	3	200.633	189.365	179.125	169.775	161.213	153.353	146.120	139.448
5	Business properties billed unmeasured water	BN2200	000	3	3.548	3.392	3.243	3.100	2.964	2.833	2.709	2.589
6	Total business connected properties at year end	BN2221	000s	3	47.779	47.640	47.438	47.268	47.133	46.998	46.862	46.720
7	Total residential connected properties at year end	BN2161	000s	3	567.629	575.674	582.233	588.807	595.295	601.562	607.605	613.483
8	Total connected properties at year end	BN1001	000	3	615.408	623.314	629.671	636.075	642.428	648.560	654.467	660.203
9	Number of residential meters renewed	BN1765	nr	0	8,284	2,300	2,300	21,823	21,823	21,823	21,823	21,823
10	Number of business meters renewed	BN1767	000s	3	0.354	0.400	0.400	2.199	2.199	2.199	2.199	2.199
11	Number of meters installed at the request of optants	BN1715	nr	0	5,672	5,246	4,822	4,460	4,133	3,837	3,569	3,324
12	Number of selective meters installed	BN1711	nr	0	7,079	6,022	5,418	4,891	4,428	4,022	3,664	3,349
13	Total number of new business connections	BP3405	000	3	0.286	0.369	0.359	0.350	0.341	0.334	0.326	0.319
14	Total number of new residential connections	BP3400	000	3	4.911	7.129	7.045	6.994	6.511	6.244	6.075	5.803
15	Total population served	BN2590	000	3	1314.810	1351.752	1362.176	1373.116	1384.321	1395.429	1406.381	1417.165
16	Number of business meters (billed properties)	BN11630	nr	0	45,243	45,251	45,252	45,247	45,234	45,215	45,190	45,160
17	Number of residential meters (billed properties)	BN11640	nr	0	359,697	378,487	396,140	412,834	428,229	442,633	456,225	468,967
18	Company area	SYS03	km2	2	7,317.15	7,342.98	7,342.98	7,342.98	7,342.98	7,342.98	7,342.98	7,342.98

Table 7.2 Wessex Water's predicted properties, metering and population data for the AMP7 period

Year	Mains Length (km)
2017/18	11935
2018/19	11980
2019/20	12025
2020/21	12070
2021/22	12115
2022/23	12160
2023/24	12205
2024/25	12250

Table 7.4 Assumed Mains Lengths before and over the AMP7 period

8 PERFORMANCE FORECAST

An analysis has been performed on historic Wessex Water data better assess the expectation of mains repair frequency over the AMP7 period and how leakage reduction is likely to affect this.

Initial analysis has been undertaken on the total mains repairs number, the mains repairs to the burst frequency metric which is subsequently converted to the providing annual forecasts.

8.1 Data analysis and statistics

8.1.1 Regression Analysis

An initial linear regression showing the relationship between leakage and mains jobs is pictured in Figure 8.1 below. This plots 15 years of data, from 2004/05-2018/19, which is likely to constitute a representative sample of consistent data sets for Wessex Water.

This relationship shows a negative correlation between the two variables, i.e. when leakage falls, mains jobs rise. The correlation coefficient R^2 is equal to 0.17, typical of a relatively weak relationship, however we are not expecting to be able to explain all the variation of mains jobs using only leakage reduction.

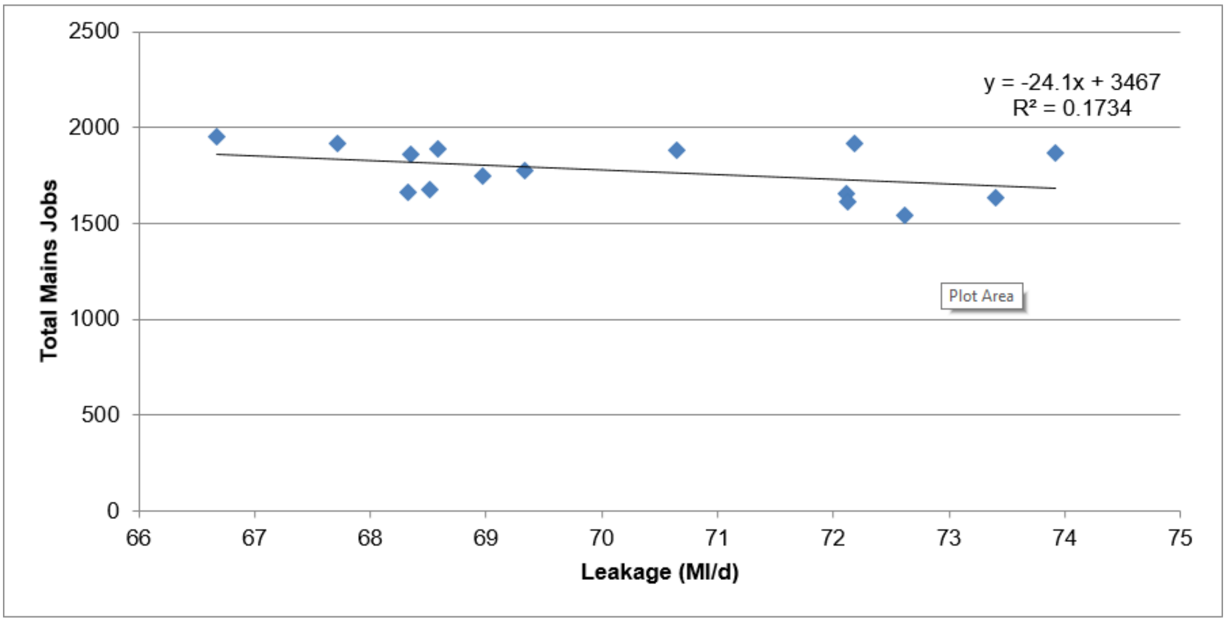

Figure 8.1 Past data suggests the number of mains jobs rises as leakage falls (2004/05-2018/19)

This relationship was subsequently broken up into its detected and customer reported components. Figure 8.2 and Figure **8.3** below show much stronger relationships (with R^2 of 0.596 and 0.595 respectively) between the detected and reported components of mains repairs, which also act in opposite directions.

This supports the assumption that as more detection and accompanying repairs are being performed, the number of reported jobs falls as there are less visible leaks to report.

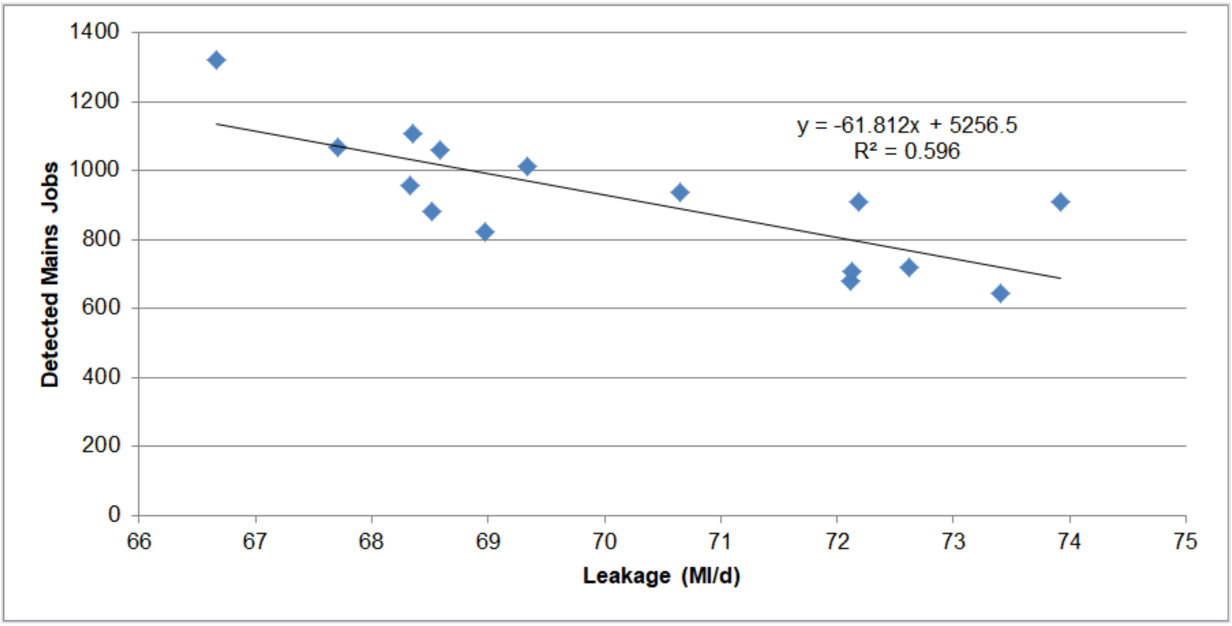

Figure 8.2 The number of detected mains jobs noticeably rises as leakage falls

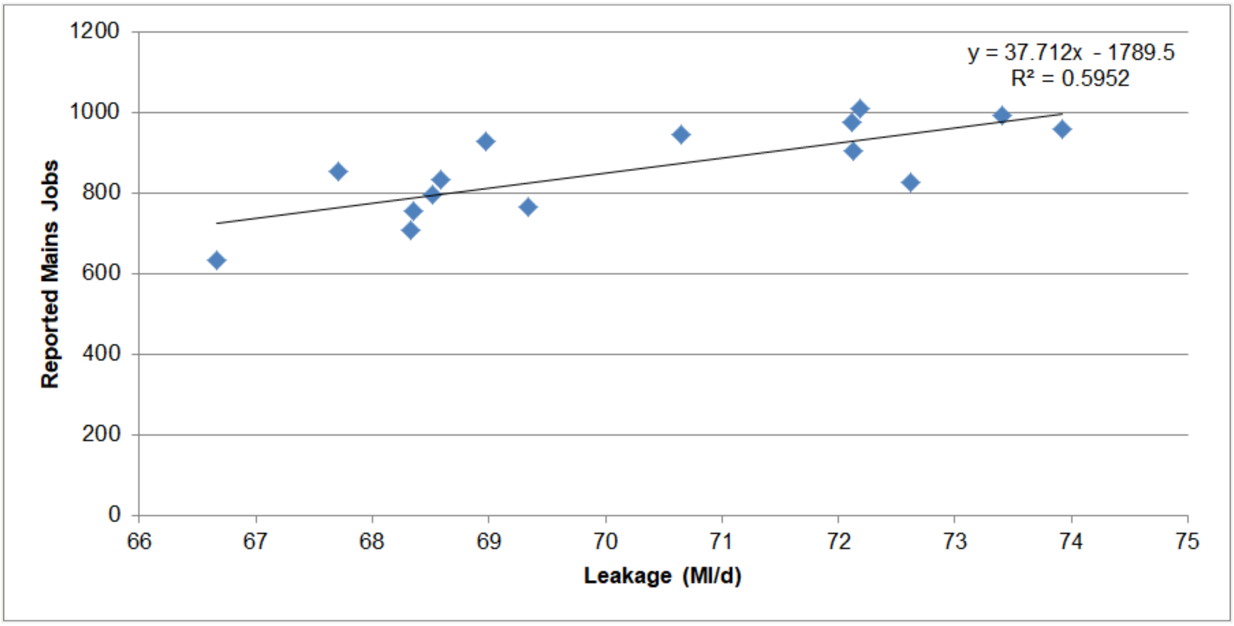

Figure 8.3 The number of reported mains jobs noticeably falls with leakage

Linear regressions were trialled for comparing mains jobs against a yearly percentage reduction in leakage, in attempt to remove the effect of the start leakage position from the relationship. These regressions are detailed in Figure 8.4, Figure 8.5 and Figure 8.6 below. These showed an extremely low level of correlation, with very small R-squared values.

To summarise, the yearly percentage leakage reduction versus mains jobs regressions have not been found to be significant and such the results have not been drawn into the predictive function. The absolute leakage position was the more significant factor than the size of the leakage reduction, with greater numbers of repairs required to maintain lower levels of leakage.

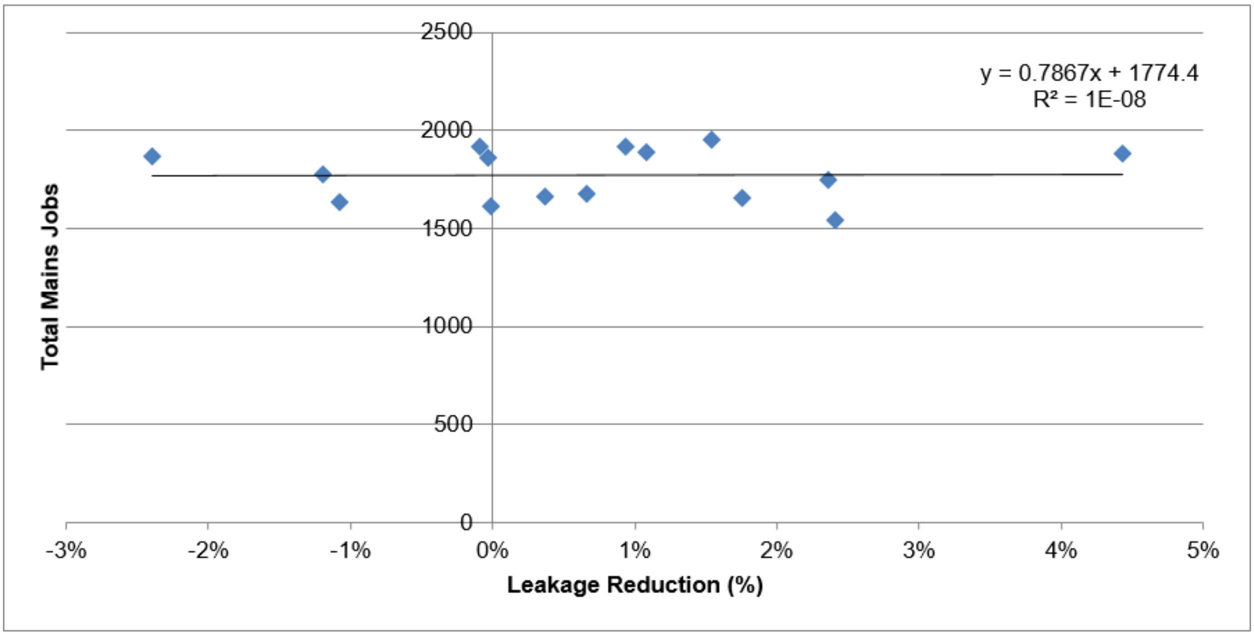

Figure 8.4 There is a very weak relationship between mains jobs and percent reduction in leakage, with an r-squared value very close to 0 (10^-8)

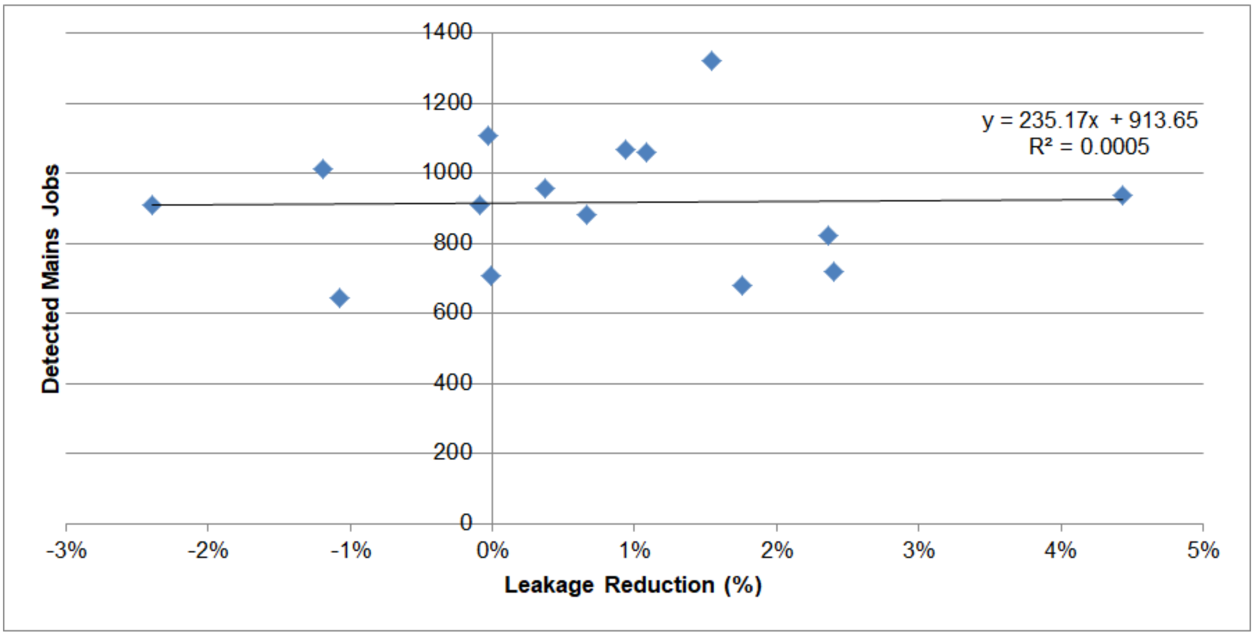

Figure 8.5 There is a very weak relationship between detected mains jobs and percent reduction in leakage, with an r-squared value of around 0.001

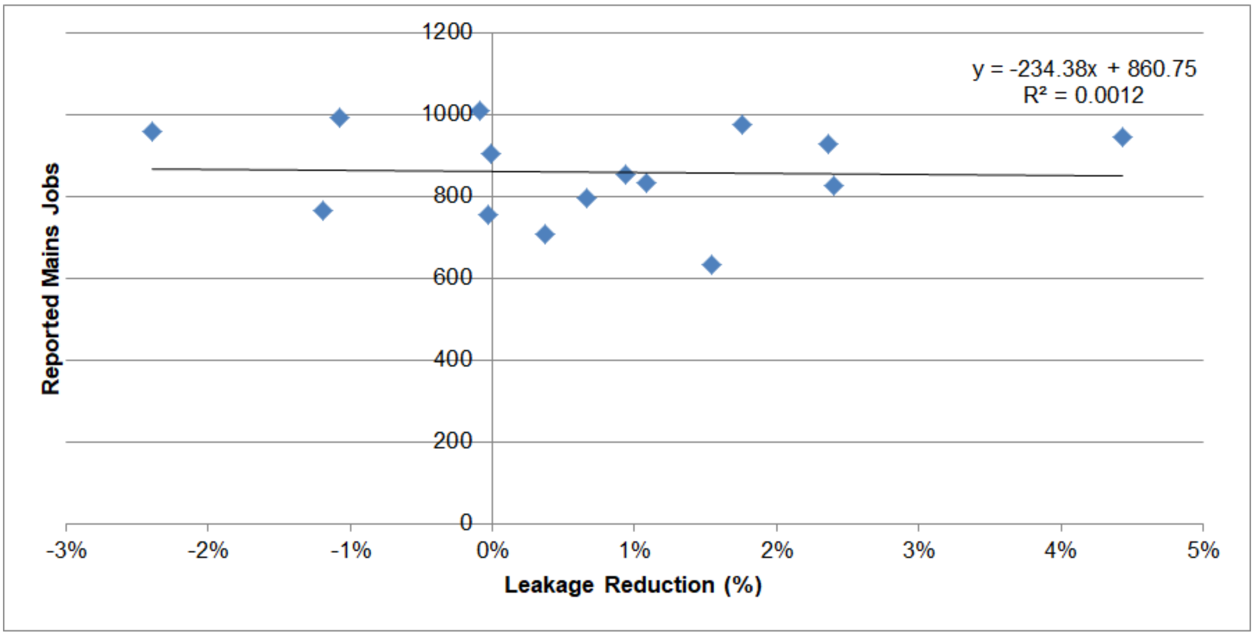

Figure 8.6 There is a very weak relationship between reported mains jobs and percent reduction in leakage, with an r-squared value of 0.001

8.1.2 Burst Rate Forecast

Error! Reference source not found. below has been constructed using the regression data from Section 8.1.1 and leakage targets from Figure 8.7 below. Figure 8.8 depicts the predicted burst frequencies over time (blue line).

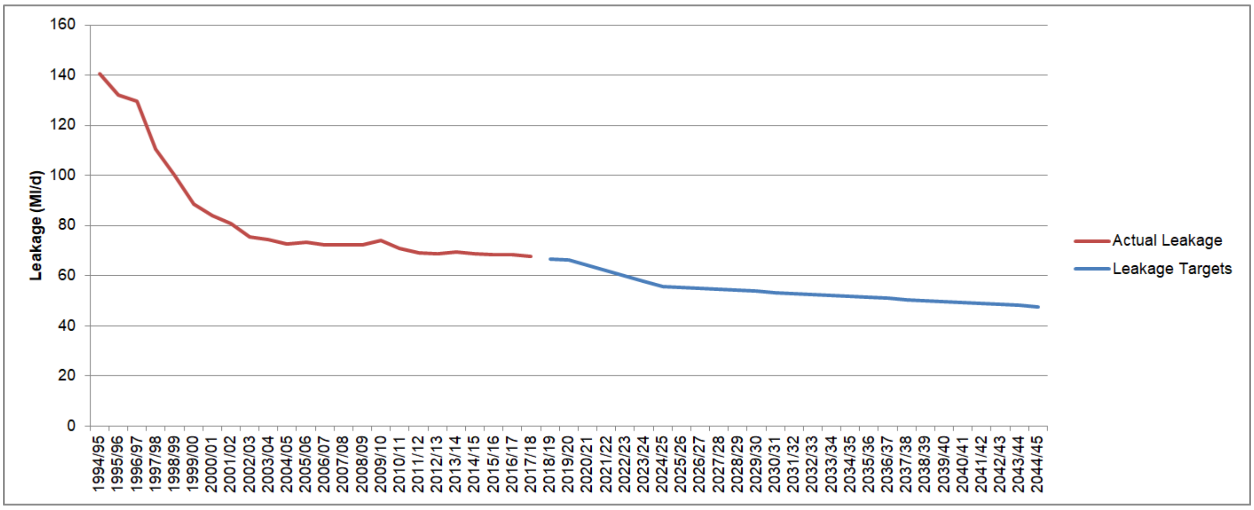

Figure 8.7 Time series of leakage and leakage targets used for prediction of mains bursts

Burst rate predictions are based on the relationship between mains jobs and the assumption that the leakage targets of Wessex Water are achieved for each year, as detailed in Section 8.1.1 above.

The predicted burst frequency is expected to exceed the committed target by 2022/23, rising clearly during the AMP7 period.

With current forecast the reductions in leakage reduce after 2024/25, this is reflected in a slower increase of predicted mains burst rates post-AMP7.

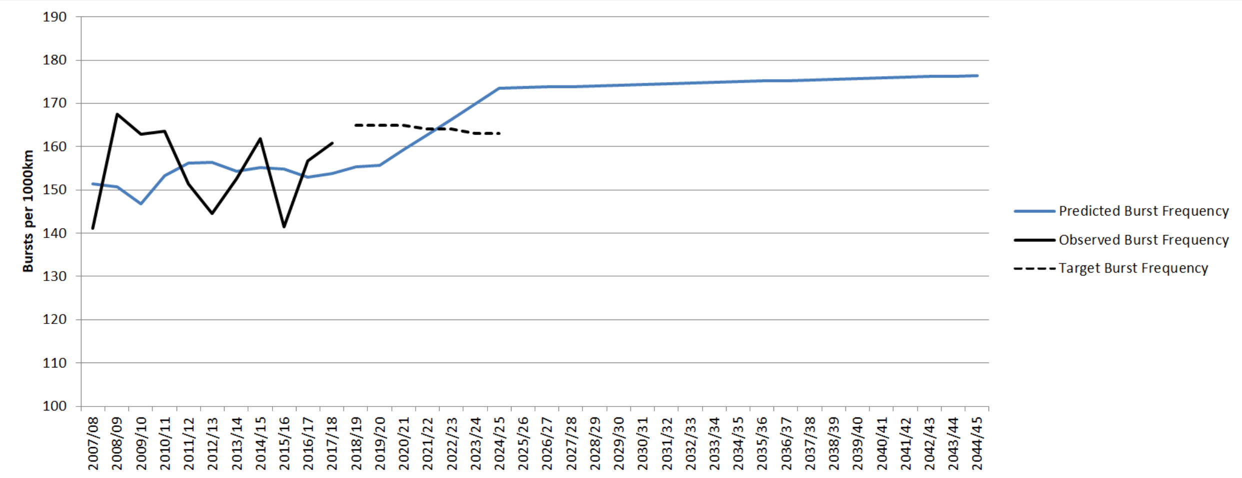

Figure 8.8 burst frequencies expected to exceed target by 2022/23 based on past data. Following AMP7 leakage reductions the rise is less pronounced as leakage reductions reduce

8.1.3 Regression Assumptions

In the statistical regression models of Section 8.1.1 above it has been assumed that the relationships between mains jobs and explanatory factors is linear. The dataset did not provide sufficient evidence that a power relationship would be more suitable.

For this high-level assessment, weather has been assumed to be a neutral factor and has not been assessed. Weather is expected to have some effect on each year and the exclusion of weather data will be represented only by the uncertainty and confidence of the current mode. Future inclusion of weather data could further explain historic differences and increase R^2 values.

It is likely that bigger leaks are the first to be found, as they are generally more obvious, meaning that at lower leakage levels smaller and smaller leaks will be found on average, thus more jobs are required to achieve a lower leakage level than the one before it. This effect could be better explained with a power regression however, this was performed and determined to not significantly improve the fit of the data. It is likely that for any single company as only a relatively small amount of data points can exist (one per year) it will be difficult to find a meaningful relationship for this phenomenon.

8.2 Policy Assumptions

The following section describes Leakage Reduction Options selected by Wessex Water together with their contribution to the AMP7 leakage reduction plan. The policies have been fully defined in Section 5 above.

8.2.1 Active Leakage Control

For ALC in general, it is typically assumed within the water industry that as ALC is performed, the number of detected repairs rises, while the reported repairs falls. This relationship is supported by the data analysis in Section 8.1.1, with strong R^2 values between both the reported and detected mains repairs and the overall leakage. This is also supported by the UKWIR report *Best Practice for the Derivation of Cost Curves* *in Economic Level of Leakage Analysis*[6], which states: “There is anecdotal evidence that increasing levels of ALC will result in reduced reported bursts. This is consistent with the concept of a growing leak that becomes “reportable” over time and is detected early by ALC activities rather than being reported”

This report also provides another assumption: “The overriding principle is that the cost of reducing leakage by 1 unit is less at higher leakage levels, for example because the leaks running are larger but no more expensive to detect or fix”. This strongly suggests that at higher leakage levels leaks are on average larger, which would imply that as leakage is reduced more jobs are required to keep up with the same level of leakage reduction.

The likely forecast for number of mains repairs resulting from ALC has been based the regression relationships based on historic Wessex Water relationships to leakage level (section 8.1 above), with a further adjustment for the forecast impact of pressure management (section 8.2.2 below). The mains renewal and AM2 policies are assumed to not affect the mains repairs as detailed below.

The best and worst case scenarios for ALC have been based on the 25th and 75th percentile ranges from the regression analysis, to account for uncertainty and weather related risks affecting leakage.

8.2.1.1 ALC1 – Innovation and Optimisation of existing ALC

The reduction in leakage associated with this policy is assumed to be an increase in cost/time efficiency of the work. As a result, the change on number of jobs caused by decreased leakage is expected to hold and the assumptions of general ALC are expected to apply to this policy.

8.2.1.2 ALC2 – Increased Active Leakage Control Activity

The reduction in leakage associated with this policy is brought about through the hiring of more detection staff. The general assumptions of ALC are expected to apply to this policy.

8.2.1.3 ALC3 – Optimisation through better data

The reduction in leakage associated with this policy is brought about through the better data collection and analysis this should lead to better targeting for detection activities. As the targeting is not expected to be based on size of leaks, the general assumptions of ALC are expected to hold for this policy.

8.2.2 Pressure Management

8.2.2.1 PM1 – Pressure Management Optimisation

Whilst increasing ALC activity and thereby increasing disruption to the distribution network can have a detrimental impact on the number of mains bursts, pressure management can *actively* contribute to a reduction in the number of mains bursts occurring.

As pressure management is primarily used for the reduction of leakage in DMAs through network calming and lowering strain on pipes, it is assumed that the leakage reduced through pressure management is directly related to a reduction in breakout. Thus, it is also assumed that a pressure managed system will reduce the growth rate of leaks. This is supported by the UKWIR report *The Effect of Pressure Reduction*

[6] (2011) Best Practice for the Derivation of Cost Curves in Economic Level of Leakage Analysis – UKWIR 11/WM/08/46

on Burst Frequency[7] which asserts that "implementation of pressure management generally results in a reduction in the number of repairs in subsequent years". This report later goes on to statistically confirm this relationship; "A statistically significant relationship was developed between pre and post pressure management repair rates. The higher the pre-pressure management repair rate: the greater the repair rate reduction".

For these reasons, we believe it appropriate to use the NRRt T3 function, from the UKWIR report *Factors Affecting the Natural Rate of Rise of Leakage*[8] as an estimator for the likely change in mains bursts, as a result of this leakage reduction caused by pressure management optimisation.

The best and worst case scenarios for pressure management have considered the uncertainty inherent in the prediction in addition to the weather related risks that impact on NRR and leakage. The best case scenario assumes that leak outbreak reduced the equivalent of an additional 1 Ml/d of NRR (3 Ml/d total), which is 50% more than the planned 2 Ml/d scenario. The worst case scenario assumes a reduction in the benefit to NRR to 1 Ml/d (50% less).

8.2.3 Mains Renewal

The current default position for Wessex Water regarding mains renewal is to keep the current replacement rate. Based on Figure 8.9 below, the burst rate under this position is not expected to largely change until around 2030, where it begins to increase over time. However, Figure 8.9 excludes the impact of the 15% leakage reduction in AMP7 and any further leakage reduction thereafter.

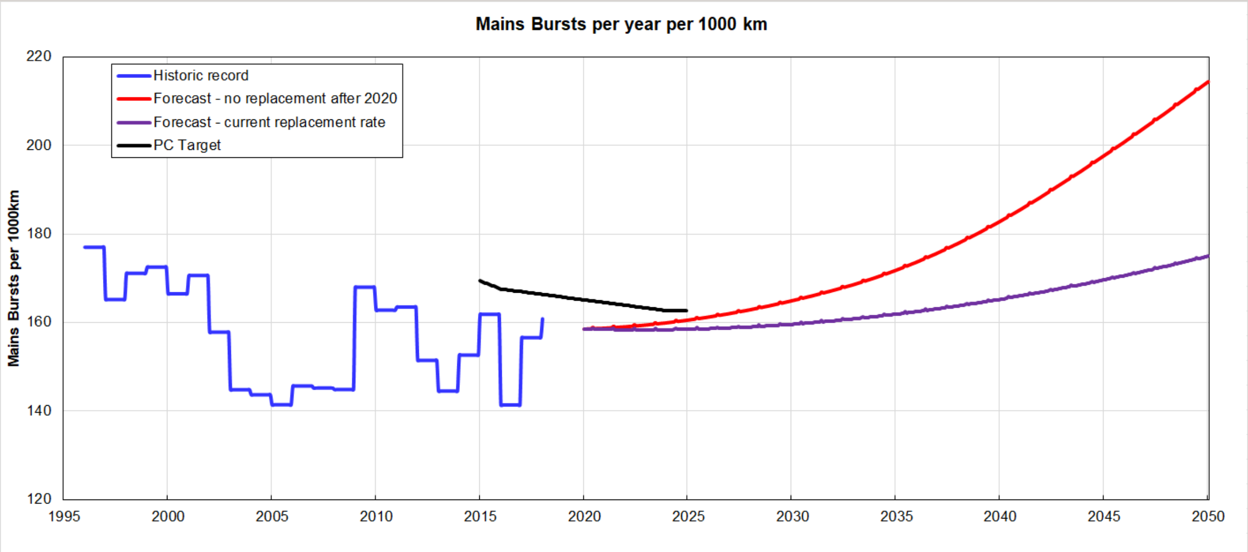

Figure 8.9 Wessex Water have provided a future forecast for burst rate, assuming the current replacement rate and no significant change in leakage levels

[7] (2012) The Effect of Pressure Reduction on Burst Frequency – UKWIR 12/WM/04/8

[8] (2008) Factors Affecting the Natural Rate of Rise of Leakage – UKWIR 09/WM/08/40

It can be assumed that mains renewal activities reduce the number of mains jobs; this is supported by Figure 8.9 and further supported by the UKWIR report *The Impact of Burst-Driven Mains Renewals on Network Leakage Performance*[9], which quantifies this result with the following: “On the whole results also suggest an immediate reduction to leakage in the range of 8% to 15% over the 5 years post-completion of burst-driven mains renewal. On more detailed investigation the greatest reductions were evident in large burst-driven renewal programmes more than 20% of the DMA”.

Over the short term, it is likely that mains renewal work could cause an initial increase in repairs due to any stress that the work itself causes to the system, as also detailed in the same UKWIR report[9].

AM2 – Better DMAs

This policy is based around creating several smaller DMAs so that more optimal targeting and leakage management can be achieved. Through this change it is not expected that this will change the numbers of repairs, but instead achieves a reduction in leakage through the increase in efficiency achieved by a reduction in leakage awareness resulting from improved targeting of these new DMAs.

8.3 Forecast scenarios

For each of the Wessex Water leakage reduction policies, forecasting scenario tables have been made to show how the policies may affect the mains repair number of the AMP7 period. These scenarios are based on the assumptions of Section 8.2.

8.3.1 Active Leakage Control

The following tables detail the effect of each active leakage control policy option on the annual number of mains repairs.

8.3.1.1 ALC1 – Innovation and Optimisation of existing ALC

This section details the effect on burst numbers by implementation of the ALC1 policy with table 8.1 and table 8.2 detailing the range of annual job numbers for best case, likely and worst-case scenarios.

Policy	Annual job numbers				
ALC1	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1856	1865	1874	1882	1890
Likely	1883	1894	1905	1917	1928
Worst	1911	1923	1937	1951	1965

Table 8.1 Annual mains jobs resulting from policy ALC1

[9] (2018) The Impact of Burst-Driven Mains Renewals on Network Leakage Performance – UKWIR 18/WM/08/67

Policy	Cumulative change in job numbers				
ALC1	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-16	-7	2	10	18
Likely	11	22	34	45	56
Worst	39	52	65	79	94

Table 8.2 Cumulative change in mains jobs relative to the base position resulting from policy ALC1

8.3.1.2 ALC2a – Increased Active Leakage Control Activity

This section details the effect on burst numbers by implementation of the ALC2a policy with table 8.3 and table 8.4 detailing the range of annual job numbers for best case, likely and worst-case scenarios.

Policy	Annual job numbers				
ALC2a	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1840	1859	1876	1892	1908
Likely	1894	1917	1939	1961	1984
Worst	1949	1975	2002	2030	2059

Table 8.3 Annual mains jobs resulting from policy ALC2a

Policy	Cumulative change in job numbers				
ALC2a	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-32	-13	4	20	36
Likely	23	45	67	89	112
Worst	77	103	130	158	187

Table 8.4 Cumulative change in mains jobs relative to the base position resulting from policy ALC2a

8.3.1.3 ALC2b – Increased Active Leakage Control Activity

This section details the effect on burst numbers by implementation of the ALC2b policy with table 8.5 and table 8.6 detailing the range of annual job numbers for best case, likely and worst-case scenarios.

Policy	Annual job numbers				
ALC2b	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1848	1862	1875	1887	1899
Likely	1889	1906	1922	1939	1956
Worst	1930	1949	1970	1990	2012

Table 8.5 Annual mains jobs resulting from policy ALC2b

Policy	Cumulative change in job numbers				
ALC2b	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-24	-10	3	15	27
Likely	17	34	50	67	84
Worst	58	77	98	119	140

Table 8.6 Cumulative change in mains jobs relative to the base position resulting from ALC2b

8.3.1.4 ALC3 – Optimisation through better data

This section details the effect on burst numbers by implementation of the ALC3 policy with table 8.7 and table 8.8 detailing the range of annual job numbers for best case, likely and worst-case scenarios.

Policy	Annual job numbers				
ALC3	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1840	1859	1876	1892	1908
Likely	1894	1917	1939	1961	1984
Worst	1949	1975	2002	2030	2059

Table 8.7 Annual mains jobs resulting from policy ALC3

Policy	Cumulative change in job numbers				
ALC3	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-32	-13	4	20	36
Likely	23	45	67	89	112
Worst	77	103	130	158	187

Table 8.8 Cumulative change in mains jobs relative to the base position resulting from policy ALC3

The combination of policies listed above supports the high-level regression of historic data based on Wessex Water's 'combined historic ALC policies'.

8.3.2 Pressure Management

The following section details the effect of the pressure management optimisation control policy option on the annual number of mains repairs.

8.3.2.1 PM1 – Pressure Management Optimisation

Table 8.9 and Table 8.10 below have been constructed from the effect that a change in AZNP causes to the NRRt according to the T3 function from the UKWIR report *Factors Affecting the Natural Rate of Rise of Leakage*[10].

[10] (2008) Factors Affecting the Natural Rate of Rise of Leakage – UKWIR 09/WM/08/40

We have previously assumed that changes in mains repair numbers caused by pressure management are proportional to the NRRt value. The NRR volume was converted to an annual percentage reduction prior to any analysis being undertaken.

This table can thus be thought of as the percent of change in mains jobs caused by pressure management.

The “Best” scenario describes a 6% reduction in AZNP per year, for an overall 0.27% (1 – 0.94^5) reduction over AMP7. The “Likely” scenario describes a 4% reduction in AZNP per year, for an overall 18% (1-0.96^5) reduction over AMP7, this likely scenario is consistent with the reduction in AZNP required to achieve a 2Ml saving through reduction in NRRt. The “Worst” scenario describes a 2% reduction in AZNP per year, for an overall 10% (1-0.98^5) reduction over AMP7.

Policy	Annual job numbers				
PM1	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1837	1803	1770	1739	1709
Likely	1849	1826	1804	1782	1761
Worst	1860	1849	1838	1826	1815

Table 8.9 Annual mains jobs resulting from policy PM1

Policy	Cumulative change in job numbers				
PM1	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-35	-69	-101	-133	-163
Likely	-23	-46	-68	-90	-111
Worst	-12	-23	-34	-46	-57

Table 8.10 Cumulative change in mains jobs relative to the base position resulting from policy PM1

It should be noted that the calculation used for Table 8.9 does not include the change in mains age, property count or mains length. These factors will change but this part of the analysis wishes to observe the change in mains NRR caused only by changing the pressure.

8.3.3 Asset Management

The following section details the effect of the pressure management optimisation control policy option on the annual number of mains repairs.

8.3.3.1 AM2 – Better DMAs

We have chosen to model policy AM2 as having no effect on mains repairs over time. The leakage reduction caused by policy AM2 is caused by better targeting of DMA leakage, and thus may perform similarly to policies ALC1 or ALC3, however the impact of this policy on the mains repairs remains unclear.

8.3.3.2 Asset Renewal

At Wessex Water’s current replacement rate shows that the mains burst rate is expected to remain constant over the 2020/25 period, as detailed in section 8.2.3 above. As such, it is expected that this small change in burst rate will not significantly impact on the model for the AMP7 period. However, this assessment of replacement rates assumed no significant change in leakage levels and excluded the impact of the 15% leakage reduction in AMP7 and any further leakage reduction thereafter.

8.3.4 Combined Leakage Reduction Policies

This section details the combined effect of all policies listed in sections 8.3.1 through 8.3.3. Table 8.11 and table 8.12 detail the range of annual job numbers for best case, likely and worst-case scenarios.

Policy	Annual job numbers				
Combined	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	1732	1760	1784	1805	1826
Likely	1922	1972	2022	2073	2125
Worst	2112	2184	2261	2340	2423

Table 8.11 Annual mains jobs resulting from all policies

Policy	Cumulative change in job numbers				
Combined	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	-140	-112	-88	-66	-46
Likely	50	100	150	201	253
Worst	240	312	389	468	552

Table 8.12 Cumulative change in mains jobs relative to the base position resulting from all policies

Wessex Water are required to report the annual number of mains jobs per 1000km of mains.

Table 8.13 details the annual numbers of mains jobs taken from Table 8.11 divided by the annual mains lengths detailed in Table 8.14.

	(Bursts per 1000km)				
Burst Rate	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Best	144	145	147	148	149
Likely	159	163	166	170	173
Worst	175	180	186	192	198

Table 8.13 Mains jobs caused by all policies

	2020/21	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Mains Length (km)	12070	12115	12160	12205	12250

Table 8.14 Assumed mains length at current rate of mains growth

9 SUMMARY AND CONCLUSIONS

Wessex Water's historic data clearly shows that as their leakage levels have been reduced there has been an increase in the number of mains bursts. This does not necessarily mean that there is an increase in burst breakout rate, indeed the additional bursts may well have been running and remained undetected from previous years.

As leakage levels have fallen, due to the increase in ALC activity, there has been an increase in the number of detected bursts and a reduction in the number of customer-reported bursts. The combined impact is an overall increase in mains bursts.

The analysis shows a much stronger correlation between absolute leakage level and mains burst numbers, than to the relative size of the leakage reductions. In transitioning to lower leakage levels the evidence is that mains burst numbers remain higher to maintain the lower leakage levels achieved.

Figure 9.1 below shows that based on the assessment of historic trends, the predicted burst frequency is expected to exceed the committed target by 2022/23, rising clearly during the AMP7 period.

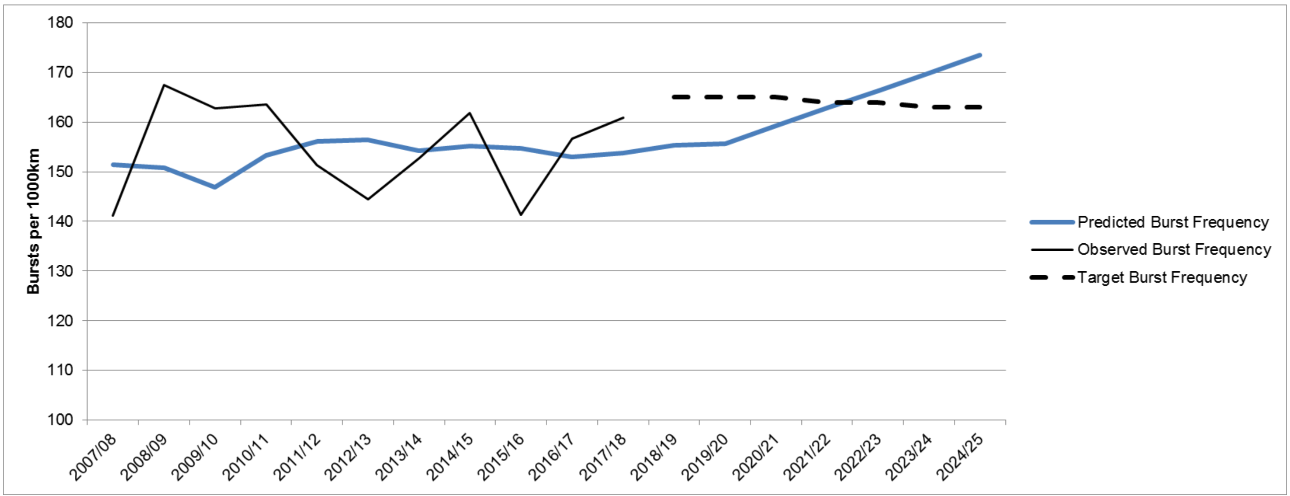

Figure 9.1 burst frequencies expected to exceed target by 2022/23 based on historic data

Table 9.1 below shows the most likely scenario on burst rates arising from the planned AMP7 leakage reduction options selected by Wessex Water and in the context of their ongoing mains replacement programme. This clearly shows the additional leakage reduction will result in an increase in mains bursts/repairs which is not due to underlying network asset health, but results from repairing existing leaks to meet the new leakage targets.

Scenario	Bursts per 1000km				
	2020/21	2021/22	2022/23	2023/24	2024/25
Worst	175	180	186	192	198
Likely	159	163	166	170	173
Commitment	<165	<164	<164	<163	<163
Best	144	145	147	148	149

Table 9.1 Company mains burst performance scenarios

The likely scenario is based on average weather. Some of the variability between the best and worst scenarios accounts for the impact of weather (dry summers and/or extreme winters) which can have a significant impact on any one year's data, which is illustrated by the variability of the historical data.

The conclusion from the most likely scenario shows that the commitment to Ofwat is a challenging and stretching target, especially from 2022/23 onwards and continues to be so as leakage levels are reduced further.

Whilst some of the planned ALC policies do not adversely affect burst rate, and pressure management interventions should reduce the burst rate, there remains an overall increase in forecast mains burst rate resulting from intensive ALC activity and reducing leakage levels. However, the results show that whilst the overall mains burst numbers increases, the proportion that are reported by customers reduces. It is therefore anticipated that this will result in an improvement in overall customer satisfaction for Wessex Water.