South Staffs Water

incorporating

CAMBRIDGE WATER COMPANY

Maintaining the serviceability of the network

Business Strategy

December 2013

Executive Summary

Maintaining the serviceability of the network accounted for one third of the capital expenditure during AMP5, with more than 80% of this invested asset renewal. This level of expenditure has been necessary to maintain a position of 'stable' serviceability.

The Company is proposing a strategy for AMP6 that will continue to maintain the 'stable' service position that is critical for meeting customers' expectations. This strategy has been designed around customer expectations and values, with a discernable focus on affordability, but also on the longer-term performance of these assets.

Headline contents of this strategy are:

Less smaller diameter mains renewal, with continued maintenance programme
Renewal of distribution mains is decreased from AMP5 levels for both regions to create an affordable plan, whilst still maintaining performance over the AMP6 period. This is possible due to the achievement of stable serviceability, but also due to improved effectiveness of renewal targeting and an on-going programme of burst management through pressure optimisation. This reduction in spend also offsets an increase in the amount of large diameter renewal activity required
Maintenance activity such as network flushing and proactive replacement of CPs under R&M is proposed to continue at current levels
Revised leakage targets
New targets derived through analysis based on the principles of the sustainable economic levels of leakage, to provide best overall value for customers and the environment. AMP6 targets are being proposed as a range to allow for extreme weather impacts
More focus on trunk mains
Increased amount of trunk main renewal in AMP6 – although the programme has been carefully considered to avoid large bill impacts, whilst balancing risk to service
Continued programme of associated trunk main fittings maintenance
Increased investment in high risk assets such as pipe bridges and non-return valves
Maintenance and upgrade of cathodic protection systems on strategic pipelines
Uplift in network reinforcement and resilience
Higher investment to target vulnerable areas of the network, responding to customer values for reliability of supply
Implementation of a live network
Developing the capability to remotely assess, monitor and control the distribution network, delivering a more responsive and reliable service to customers
Monitoring high consequence trunk mains. Avoiding the need to renew high risk assets by mitigating the consequences with better value monitoring solutions. This will provide the potential for advanced warning of catastrophic trunk main failures; enabling pre-emptive actions to be taken to reduce or prevent customer impacts
Deferral of large diameter PVC renewal work
Using a risk based approach to extend the proposed replacement of all large diameter PVC mains over one extra AMP period. Still intending to renew all of these high risk assets and still prioritising the 'highest risk' PVC mains for AMP5 and 6, but deferring schemes to AMP7 where possible in order to make the forthcoming plan more affordable
Smarter asset management
Further combining the asset management of infrastructure and non-infrastructure assets under one asset management plan and team, allowing management of risks across the entire network

Exploiting knowledge and processes, and exploring innovative opportunities, from across the Cambridge and South Staffs regions to deliver better solutions for customers

The infrastructure assets are aging, with a network of over 8,300km of mains averaging 47 years old. These assets are responsible for delivering 400 million litres of water to a population of 1.5 million customers every day; the following programme of maintenance, renewal and reinforcement work is considered vital if these assets are to continue deliver this service, whilst positively contributing towards the delivery of the five customer outcomes proposed within the overall business plan.

The customer engagement undertaken during the preparation of this business plan has measured the relative importance of each aspect of the service received. This has reinforced the importance that customers place on the delivery of a reliable water supply, with good water quality and appropriate leakage management, at the lowest possible cost. In response to this input, and in response to the industry wide focus on affordability, the Company is proposing an optimised mix of maintenance and renewal activity which has been thoroughly challenged internally and by the Customer Challenge Group.

The levels of investment proposed for the maintenance of network assets is increasing to £54.6m for AMP6; up by 5.3% from AMP5. The chart in figure 1 shows the breakdown of these amounts, demonstrating the increased focus on trunk main assets, network resilience and leakage management. This has then been deliberately offset, by using a risk based approach to reduce investment on small diameter distribution and large diameter PVC renewals, ensuring that the plan remains affordable for customers but maintains the levels of service expected.

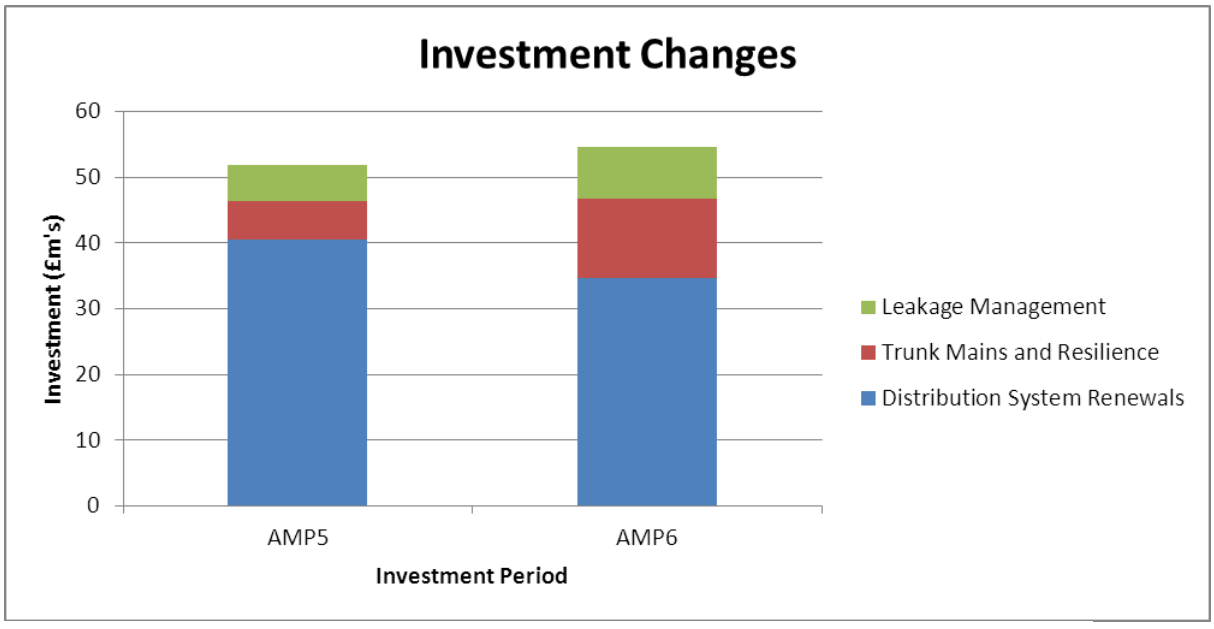
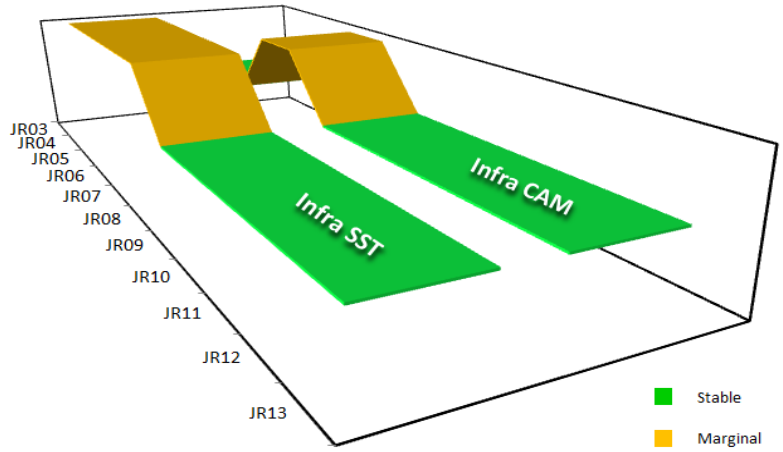


Figure 1: strategic changes in investment proposed for the three key asset groups

Contents

1. Introduction

This strategy outlines the Company's capital maintenance plans for its network assets, which aims to maintain their stable serviceability and resulting service to customers for AMP6 and beyond.



The Company achieved stable serviceability for its network assets in 2007/08 for both the South Staffs and Cambridge regions, following a period of marginal performance where burst mains were a particular issue. This level of service has been maintained throughout AMP6.

Network serviceability is assessed using six key service indicators, for which the Company have expected performance thresholds.

These service indicators are shown in the following table are directly linked to the performance measures associated with the Company Outcomes.

Indicator	Reference Level SST	Control Limits SST	Reference Level CAM	Control Limits CAM
Burst mains	1210	Higher = 1149 Lower = 971	327	Higher = 390 Lower = 263
No water complaints	60	Higher = 120 Lower = 0	12	Higher = 66 Lower = 0
Low pressure complaints	0	Higher = 47 Lower = 0	17	Higher = 34 Lower = 0
MZ non-compliance Iron (%)	0.165	Higher = 0.38 Lower = 0	0	Higher = 0.16 Lower = 0
MZ non-compliance Turbidity, Iron and Manganese (%)	0.03	Higher = 0.12 Lower = 0	0	Higher = 0.2 Lower 0
Discolouration complaints (per 1000 population)	1.11	Higher = 1.49 Lower = 0.74	0.23	Higher = 0.29 Lower = 0.17

The performance of the 8,300km network is critically important for managing the service experienced by customers, delivering 400 million litres of water to a population of 1.5 million every day. In addition to hitting serviceability targets, the Company is determined to ensure that the customer experience is also managed. In order to do this, the investment strategy has been optimised against areas of service that customers value, as described in the Company's outcomes:

	**Excellent water quality (now and in the future)** This can be managed by renewal and refurbishment of mains, maintenance of fittings, operational flushing of the network and live monitoring of in-network water quality parameters.
	**Secure and reliable supplies (now and in the future)** This outcome receives the most benefit from the network investment strategy. Mains renewal, maintenance of fittings, network resilience / reinforcement and the maintenance of control valves all contribute towards maintaining a reliable platform for conveying water from pumping stations to customer taps.
	**An excellent customer experience to customer and the community** The proposed programme will contribute towards responsive and informed customer communication, especially projects such as the 'live network'.
	**Operations which are environmentally sustainable** The achievement of this outcome relies on managing leakage, and maintaining the trunk mains network to ensure efficient pumping.
	**Fair customer bills and fair investor returns** The Network investment strategy proposed has been carefully considered to optimally balance immediate capital expenditure with on-going operational costs. The Company has also taken care to avoid under-investing, compromising future performance of these assets at the expense of future generations.

The on-going achievement of the individual serviceability targets requires a complex range of capital investment and operational activity. To achieve these targets, significant effort has been spent ensuring that the proposals are ambitious, but affordable to customers; balancing investment across the areas that customers value, whilst still investing in the areas that the Company believes are important for sustaining long term asset serviceability for AMP6 and beyond. This response to customer values is evidenced throughout the strategy, as the Company focuses on delivering continued reliable supplies, one of our customers' primary requests.

For ease of reading, the investment needed to maintain the serviceability of infrastructure assets has been split into three key sections:

Trunk Mains and Resilience	**Distribution System Renewals**	**Leakage Management**
• Trunk main condition assessment • Trunk mains maintenance • Resilience and reinforcement of network • Trunk main renewals • Trunk main monitoring	• Condition assessment • Small diameter renewals	• Leakage strategy • Short Run SELL • Long Run SELL • Leakage asset maintenance • Target Setting

Each section of this strategy will explore the reasoning and justification for investment. Future investment proposals are then outlined and compared against historic levels of investment, before conclusions and selected solutions are described.

Note that this document is written with an assumption that readers have already reviewed previous sections of the business plan. Specifically, the document assumes familiarity with the Company's general 'Long Term Strategy', Customer 'Outcomes', and the approach to investment scenario development and subsequent optimisation. The document also contains highlighted segments to aid readability, with:

- key points and summaries shown in blue boxes;
- investment scenarios described in grey boxes and
- internal/external challenge points shown in yellow boxes

2. Asset Management Approach

The asset management team are in a fortunate position with respect to infrastructure assets, having asset manager's that are involved with the day-to-day operation of the network, thereby possessing detailed knowledge of investment needs. These same asset managers have been used from the inception of this management strategy, forming base investment needs that have evolved and developed to form the proposals that are detailed in the following sections. These proposals follow the same procedure as adopted by the whole business, developing an 'identification of investment need' into five investment scenarios for every solution, from a reactive ('do nothing') option right through to a 'premium' option. Each of these investment scenarios are designed to cover a range of options, from carrying additional asset related risks by investing at a low level, through to reducing asset related risks by investing at high level. Each option is then optimised and assessed using the investment optimisation (IO) method described in the earlier IO strategy document.

The scenarios proposed for infrastructure assets have been optimised against non-infrastructure investment proposals. This has balanced the investment across these two key asset areas in accordance with the level of need identified by the asset managers. Proposals for each of Company's supply zones have also been discussed collaboratively within the asset management team, to ensure that projects on the network assets (infrastructure) are aligned and timed to fit with or around projects at production sites (non-infrastructure).

Further information about general asset management processes and governance can be found in the asset management business strategy.

Asset managers for infrastructure assets also benefit from a reliable and comprehensive database for both asset information and related failures. Each region has full network coverage within the geographic information system (GIS), giving a good asset database for analysis purposes. Each region has also collected and maintained a significant amount of data for historic failures and measures of service; as one example, the Cambridge and South Staffs region have 17 and 16 years of recorded bursts data respectively, with maintained links to network assets. This asset and failure data is the basis for many of the business cases described within this strategy.

3. Trunk Mains and Resilience

Trunk mains are a key part of the distribution network and failures can potentially have large scale consequences. The Company has been evolving a strategy for these assets throughout AMP5, aiming to ensure that investment is sufficient to maintain serviceability now, yet also wide enough in scope to ensure secure and sustainable performance for future decades, with the aim of avoiding the need for unaffordable 'step changes' during future price reviews, something our customers have told us that they do consider to be appropriate.

There are 830km of trunk mains in the South Staffs region and a further 652km of trunk mains in the Cambridge region. These are disproportionately high lengths of main relative to the total length of the two regional networks, ranking the combined Company (SSC) 4th in the industry (based on diameter banded asset lengths from shared June return data). In the Cambridge region, this high proportion of trunk mains is required to support the large number of groundwater stations. In the South Staffs region, this high proportion of trunk mains is characteristic of the highly urbanised and industrial demographic. This high proportion of assets is potentially challenging and expensive to maintain, necessitating a thorough and innovative approach for developing investment needs.

The Company is confident that the proposals in the following section constitute a sensible compromise for managing trunk mains, ensuring recommended AMP6 projects are affordable with maintenance being preferred to renewal, but also concentrating on innovative ways to minimise risk and build understanding. However, it is the Company's expectation that trunk mains and associated fittings renewal will need to increase from AMP7, for SSC and the rest of the industry, therefore, some of the proposed AMP6 investment is rightly focussed on ensuring that the Company is at the forefront of the industry with its detailed risk analysis of every section of pipe. This risk analysis will ensure that future increases in investment can be minimised and any investment can be targeted as effectively as possible.

The Company is currently part way through a multi-year project to build and populate a comprehensive trunk mains risk register. The aim of this project is to catalogue every section of trunk main and then to assess the probability and consequence of failure for each 50m section; in total, over 29,500 individual sections will be registered.

The diagram in figure 2 shows the consequences that are assessed as part of this process, and includes inputs from GIS, hydraulic models, flood modelling algorithms and Ordnance Survey topographic, topological and property datasets. This assists with producing a register of risks that is built scientifically and fairly upon data and observations; which does not entirely replace expert opinion/panels that have been used previously, but provides scientific ratification and also helps to identify assets that have not previously been considered.

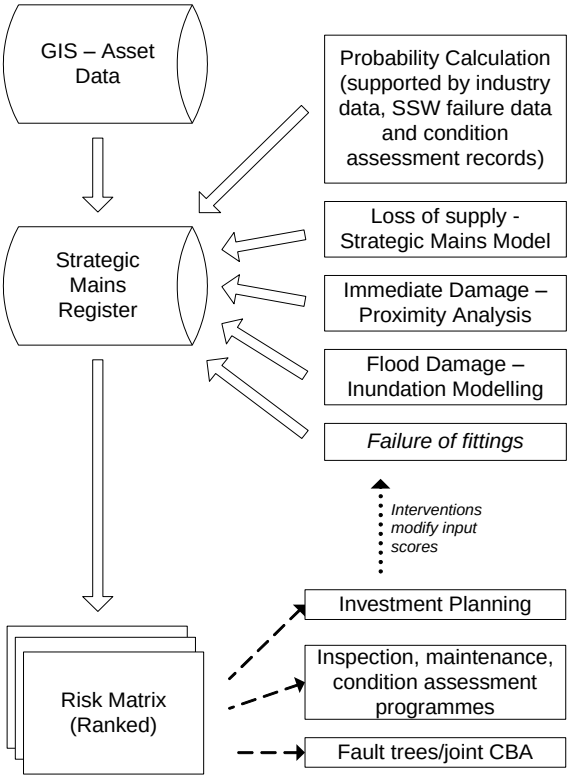
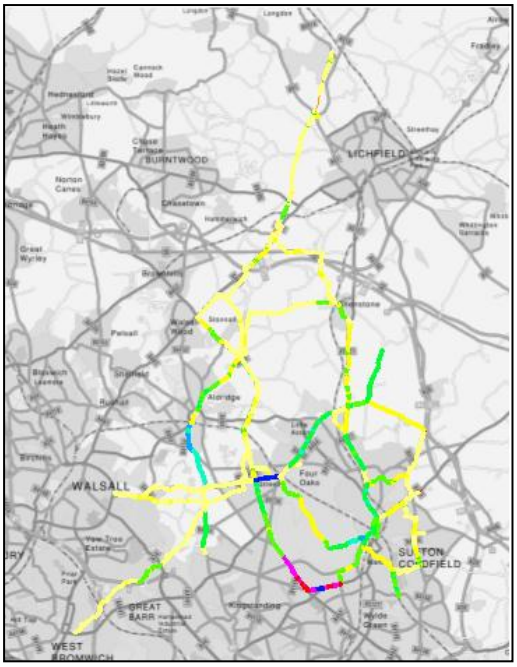


Figure 2: process diagram for trunk main register



To date, the register has supported the identification of a number of pipes requiring further investigation, and as a result, some of the investment for AMP6's condition assessment and resilience programmes will be targeted accordingly.

The register has also identified some very high consequence sections of main that are being assessed for live monitoring. In short, the Company is committed to using best practice risk based asset management for deciding investment requirements for trunk mains and is continuing with an ongoing project to develop this approach.

Figure 3: map showing themed trunk mains for Barr Beacon and Sutton supply zones. Sections highlighted in magenta and red are assessed as highest risk

3.1 Trunk Main Condition Assessment

Key Points – Trunk Main Condition Assessment	
Outcomes:	Facilitates the creation of the trunk mains risk register, indirectly supporting the delivery of all customer outcomes: 
Investment:	Very similar to previous AMP, due to continued need to develop knowledge on trunk mains
Proposal:	£0.3m = 0.16% of SSC IP

Condition assessment is a critical tool used for creating the trunk main register. Without any investment in this area, the current condition of assets is often impossible to ascertain.

Trunk mains condition assessment is typically undertaken on a 'non-destructive' basis and involves ultrasound materials testing, external visual inspection and internal under-pressure camera inspections, as shown in figure 4. This gives a reliable measure of the remaining structural integrity of the assets (through ultrasonic thickness tests) and can also determine the existence and condition of any internal and external coatings. However, the Company is always investigating technological developments and there are some potential developments in this area that could provide better information. Traditional non-destructive testing (NDT) is limited to the short length of pipe that is assessed (typically <1m length), the results are then assumed to be representative of the whole asset. There are alternative surveys that can deliver either condition or performance information, such as Smartball surveys (using leaks to judge condition), Sahara surveys (again reviewing leaks, but also visual feed) and Acoustic Resonance Testing (able to determine pipe wall condition through induced acoustic pulses).

Figure 4: non-destructive testing of a trunk main

The trunk mains within the South Staffs and Cambridge regions typically fail at less than one tenth of the frequency of the smaller diameter distribution mains. This gives very few opportunities to gauge an asset's condition based upon failure rates, and makes condition assessment critically important for understanding the probabilities of future asset failures.

The investment proposed in this area may not directly contribute to the delivery of the Company five outcomes, however, the work is considered essential for the development of the trunk mains risk register and this register is vital for the delivery of future projects that will directly affect the five outcomes.

3.1.1 Historical Service Delivery

The Company will invest a total of £313,000 on large diameter condition assessment by the end of AMP5. This is higher than in previous AMPs, but in line with the PR09 final determination, and was uplifted in order to begin the strategic review of trunk mains.

3.1.2 Delivering Future Service

The commitment of completing and populating the trunk mains register would not be possible without undertaking a minimum amount of work on condition assessment. But this work has not been mandated into the investment programme; it has been included on merit because of the benefits that are realised during the targeting and delivery of associated projects.

The following investment scenarios have been considered:

Scenario	Value	Description
Reactive		No condition assessment
Minimum	£200k	Minimum required to assess condition of trunk mains for register. Equivalent of 8 x NDTs per year
Essential	£300k	Optimal required to assess condition of trunk mains for register. Equivalent of 12 x NDT's per year

The investment optimiser selected the 'essential' scenario, which provides funding for 60 non-destructive tests during AMP6, at £5,000 for each site (or alternative techniques where appropriate and more effective). The costs have been calculated based on previous actual costs for this work, so are quoted with a high degree of confidence. This 'essential' scenario was also assessed as 'cost beneficial' during cost benefit analysis, on the basis of inefficient targeting of interventions if the work was not undertaken.

The proposed level of investment is considered sufficient to support the population and development of the trunk mains register, which in turn supports the targeting and delivery of other trunk main investment areas such as maintenance, inspection activity, live monitoring and renewal/rehabilitation prioritisation. The total investment of £300,000 is equivalent to less than 0.2% of the investment programme, whilst the total investment which is supported

by the trunk mains register is almost £12m, equivalent to 6.3% of the investment programme.

These options for condition assessment have also been considered in conjunction with the investment for trunk main live monitoring, described later in this document in section 3.7. There is potential to offset some of the above condition assessment expenditure by undertaking more monitoring work, as monitoring would also provide excavations, visual inspections and an opportunity to carry out internal camera surveys. In the final investment programme, both of these schemes were chosen at 'essential' level – offering an optimal mix of work which should deliver a step change in knowledge for these assets during AMP6.

3.2 Trunk Mains Maintenance

Key Points – Trunk Mains Maintenance	
Outcomes:	 Excellent water quality  Secure and reliable supplies  Fair customer bills
Investment:	Only 2% of total IP, but still significant uplift from previous AMPs. Proposed schemes are necessary for ensuring operability and reliability of trunk mains network.
Proposal:	£3.2m = 2.0% of SSC IP

The Company has undertaken a significant amount of inspection and maintenance work on trunk main and ancillary assets during AMP5. This project has identified many assets that are in a non-operable condition or are considered to be a high risk to the supplies received by customers. These AMP5 findings have driven several proposed schemes for AMP6, designed to continue this programme of corrective and preventative maintenance:

- Trunk Main Ancillary Maintenance
- Pipe Bridge Refurbishment
- Strategic Non-return Valves (review, repair, remove)
- Reservoir Auto Valves (for emergency isolation)
- Cathodic Protection (on strategic mains)

Each of these schemes is described in the following sections.

The work proposed is a higher level of investment than the equivalent programme delivered during AMP5. This is a direct response to the condition of assets inspected and maintained during AMP5 and is also driven by an improved ability, using the trunk mains register, to target assets with a high risk of impacting service to customers.

Each of the schemes focuses on maintaining and improving the operation of the trunk main network. Much of this work has the potential to extend the operating lives of the constituent assets and will also increase the number of strategic fittings that are operable if they are ever required during an emergency situation. Based on the expense of renewing these assets, potentially before the end of their operating life, a maintenance approach has been established as the most cost effective strategy.

3.2.1 Trunk Main Ancillary Maintenance

Through proactive maintenance the Company will return around 340 trunk main ancillary assets (such as air valves, sluice and butterfly valves) to fully operational service during

AMP5. This is in addition to inspecting hundreds of other fittings along the Company's top 20 strategic mains.

Inspections during AMP5 have shown that:

- 26% of fittings cannot be located, and are either buried or do not exist
- 18% of fittings are in reasonable condition, either requiring minor intervention or servicing
- 56% of fittings are not in serviceable condition and require intervention; of these:
    - 16% are repaired
    - 25% are renewed
    - 59% are inaccessible, requiring chamber rebuilds, significant excavations, expensive traffic management or permits to work

The 56% of fittings that are not in serviceable condition is a substantial concern for the Company. Inoperable fittings, especially air valves, increase the probability of failures occurring right across the trunk main network, from surface water ingress, through to complete structural collapse. The operation of the network is now considered to be at a critical point, with the Company not willing to risk the continual deterioration of these assets, to the extent that customers begin to be routinely affected. The following proposals are therefore designed to offset this gradual increase in the number of inoperable fittings.

To date, the in-house team have targeted the accessible assets on critical mains that can be repaired and maintained with minimal cost. Once fully operable, these assets are then regularly inspected and added to cyclical servicing programmes. For AMP6, the Company is recommending that this activity continues; with additional funding also included to allow for chamber rebuilds and excavations, doubling the number of assets that the team could feasibly return to service.

Ancillary assets have been subject to a recent UKWIR research project, which concludes that maintenance (of air valves in particular) has provable benefits for both pumping efficiency and risk of mains failure. There are also implications for water quality if unreliable fittings pose a risk of surface water ingress. For the investment scenarios outlined below, the Company has assumed a conservative reduction in the probability of a burst main of 5% for any cost/benefit analysis.

3.2.1.1 Historical Service Delivery

The internal trunk main maintenance team have been operational since late 2008 and were initially tasked with inspecting and rectifying problems along the Company's most strategic 45" mains from the Hampton Loade Treatment Works (SST region). Since then, the team have moved onto other strategic mains, inspecting and maintaining fittings.

Since 2008, some 340 trunk mains fittings have been repaired, or replaced where necessary (corrective maintenance), whilst a further 200 fittings have been covered under the proactive servicing programme (preventative maintenance).

The Company will invest a total of £188,000 during the AMP5 period, equating to an average of less than £350 per intervention, which is exceptionally competitive when benchmarked against external providers.

Figure 5: example air valve – pre and post intervention

3.2.1.2 Delivering Future Service

As described above, the investment for maintenance of these assets has been split into two projects; one is focused on the direct maintenance of assets, whilst the other is related to chamber rebuilds and excavations. Both of these projects have been optimised individually:

Maintenance project scenarios:

Scenario	Value	Description
Reactive	n/a	No maintenance team for preventative or corrective maintenance
Minimum	£315k	Preventative maintenance only – 400 of 3600 fittings (11%) Using current two man team
Essential	£625k	Preventative maintenance – 400 of 3600 fittings Corrective maintenance – 420 fittings Some chamber remediation and contract support Using current two man team
Optional	£1.2m	As essential, but increase team size by two Enables more corrective maintenance Reduces preventative maintenance cycle to c.26yrs
Premium	£1.69m	Use direct team to undertake corrective maintenance Use contract resources to undertake preventative maintenance, reducing cycle to c.16yrs.

Rebuild and excavation scenarios:

Scenario	Value	Description
Reactive	n/a	No supporting excavation or rebuild activity. Maintenance restricted to readily accessible fittings
Minimum	£315k	Sufficient support for 'minimum' or 'essential' maintenance strategies
Essential	£786.14k	Extended support for 'optional' or 'essential' maintenance strategies

The above maintenance scenarios are a continuation of the programme already underway during AMP5. The 'essential' scenario has been selecting during the investment optimisation

programme, which will repair or replace an estimated 420 fittings and continue to deliver the preventative servicing programme that is essential to ensure that fittings are not allowed to deteriorate back to an unserviceable state.

This proposal is more expensive than the current AMP5 programme. However, the inspection of fittings is now largely complete for strategic routes, so the two man team can spend more time on maintenance activity, hence the uplift from 540 interventions to 820. The IO tool has also recommended additional funding during AMP6 for chamber rebuilds and excavations (at the 'minimum' level), making previously unreachable fittings more accessible and increasing the scope of maintenance that the team can deliver.

3.2.2 Pipe Bridge Refurbishment

A targeted programme of pipe bridge refurbishment during AMP5 has delivered improvements to 12 pipe bridges, returning them to a condition where structural integrity can be assumed stable for at least the next 15 years.

A parallel inspection programme has revealed that some of these assets are in worse condition than anticipated, especially where air valve fittings, which are often in inaccessible locations, have been leaking onto the pipe wall and causing localised damage. The pipe bridges therefore have much lower estimated remaining life than the buried mains at either side of the bridge. These findings have reinforced the importance of pipe bridge refurbishment and options for continuing this programme have been developed for future AMPs.

There are 90 pipe bridges across the SSC area, mainly located in the South Staffs region.

3.2.2.1 Historical Service Delivery

All pipe bridge refurbishment work during AMP5 has been delivered by contract partners. The total value of this work is expected to be £232,000 by the end of 2014/15.

This programme will cover scaffolding, inspection, stripping and recoating/wrapping of 12 of the Company's 90 pipe bridges. Several of these have also required remedial work to supporting structures (covered by the contract) and repair work to attached air valves (covered by in-house maintenance team as part of ancillary maintenance programme).

Figure 6: Kinver lock pipe bridge before and after refurbishment (included replacement riser/air valve, new cabinet, complete blasting and recoat with epoxy)

3.2.2.2 Delivering Future Service

The following investment scenarios have been considered:

Scenario	Value	Description
Reactive	n/a	No maintenance work on pipe bridges. Carry the risk of failure into AMP7 with risk that some may be become non-viable for future remediation
Minimum	£593k	Refurbishment of all six pipe bridges which cross live railways, including full condition assessment and repairs to fittings, thrust blocks and supporting structures. Condition assessment to be undertaken on all other pipe bridges not yet refurbished.
Essential	£796k	As above, but also include refurbishment programme of top 20 strategic pipe bridges, to be completed over next two AMPs.
Optional	£1.1m	As above, but complete top 20 programme within AMP6.

As with the trunk main ancillary maintenance proposal, the pipe bridge options are a continuation of an existing AMP5 programme. The scenarios outlined in the above table generally propose an uplift of at least 100% over the AMP5 expected expenditure. This is principally due to a strategic decision to address high risk pipe bridges that cross 'live' commuter railway lines. These assets are assessed as particularly high consequence, justifying their inclusion in the AMP6 programme despite high expected costs.

Even with higher costs, all of the above investment scenarios have been assessed as cost beneficial during CBA; partly because the programmes are more ambitious with the amount of work proposed, and partly because the benefits of the 'railway' bridge refurbishments are very high.

The investment optimiser has selected the essential scenario. This includes sufficient funding to completely refurbish the six railway bridges (including full condition assessment and repair/renewal of supporting structures and attached air valves). The proposal also includes funding to continue the programme of refurbishing pipe bridges on other strategic mains. The 'top 20' pipe bridges of the remaining 72 have been identified (ranked by the criticality of the host mains); these will be refurbished during the next two AMP periods.

Challenge – CCG, Monson (South Staffs Region)
Establishing the remaining life of each pipe bridge by establishing remaining wall thickness, carrying out investigations into the possibility of moving any pipe crossings into existing or planned road or rail bridges and gathering information on costs of treating pipes over live rails prior to carrying out a programme of work.
Company Response
Future pipe bridge assessments are to include an initial assessment of mains condition via the use of hand held ultrasound devices. There is also provision in our PR14 submission for mains condition assessments both under and above ground, which will include pipe bridges. Those pipe bridges traversing live rail lines require extensive assessments to establish the viability of refurbishment or diversion. The essential scenario in our PR14 submission includes the costs of full condition assessments, NDT testing, and civil engineering assessments to enable a decision to be made regarding the most cost beneficial solution to this issue.

3.2.3 Strategic Non-return Valves

There are 131 large non return valves (>= 250mm) marked on the Company GIS (geographic information system) for the South Staffs region, and a further 51 non return valves in the Cambridge region. There are concerns that some of these are not recorded accurately, following historic programmes of work to remove gates within non-return valves located on some trunk mains.

These assets, if fully operable, will function depending purely on differential pressures and by design can rapidly close/open large sections of trunk mains throughout the network. This sudden operation has the potential to cause hydraulic pressure surges (example shown in figure 7), which can potentially cause bursts elsewhere on the network. When combined with an aging trunk main network, and an increasing propensity to operate these mains with abnormal flow speeds and directions (to overcome water shortages, drought conditions or to backfeed zones), the overall risk associated with these assets is growing.

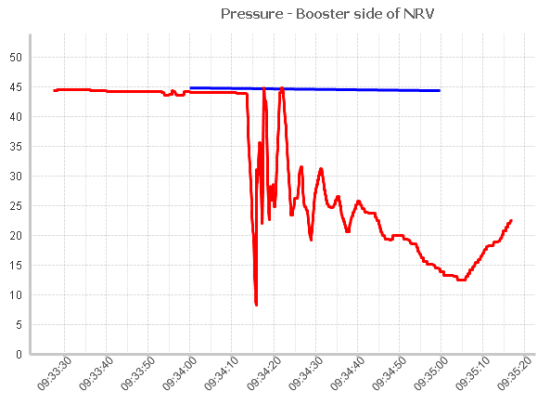


Figure 7: example 37m pressure surge near non-return valve

The proposals below are intended to investigate and remedy these risks for the most strategic areas of the network. This will involve the excavation and inspection of fittings to determine if the internal gates are present and operating normally. If not required, these gates (or the entire fittings) can then be removed to reduce risk to the network. The findings from this project can then also be used to inform future investment needs.

Figure 8: 36" multi-gate non-return valve removed during 2011

3.2.3.1 Historical Service Delivery

No proactive maintenance or asset surveys have been undertaken on strategic non-return valves during AMP5. Although, as shown above, one 36" fitting has been removed and tested during the repair of a burst on a nearby bypass main.

3.2.3.2 Delivering Future Service

The following investment scenarios have been considered:

Scenario	Value	Description
Reactive	n/a	No proactive work, but continue with post-burst investigations and use of surge logging/modelling to assess and track down risks
Minimum	£400k	Inspect and then remove or repair 13 NRVs in the strategic Barr Beacon supply zone (15" to 27" diameter)
Essential	£1.03m	Inspect and then remove or repair 67 NRVs in the top 4 strategic zones: Barr Beacon, Outwoods, Shavers End & Sedgley (250mm to 36" diameter)
Optional	£1.22m	Inspect and then remove or repair 78 NRVs in the top 6 strategic zones: Barr Beacon, Outwoods, Shavers End, Sedgley, Walsall & West Bromwich (250mm to 36" diameter)
Premium	£1.48m	Inspect and then remove or repair 97 NRVs in the top 8 strategic zones: Barr Beacon, Outwoods, Shavers End, Sedgley, Walsall, West Bromwich, Cannock High & Springsmire (250mm to 36" diameter)

The above scenarios are considered to be conservative, targeting a relatively small proportion of the large non return valves installed across the trunk main network. This is a deliberately focussed strategy which enables the Company to learn from the findings during the AMP6 programme and then use this information to determine future strategies for addressing the risks posed by these assets.

The above proposals have been created to systematically target strategic zones. The investment optimiser has selected the minimum scenario, investigating and then removing, renewing or repairing 13 valves within the Barr Beacon zone. The higher level of investment in the essential scenario was initially preferred, but this was later revised due to financial constraints *(note that the CCG challenge below was based on an interim programme containing the essential scenario)*.

This project is part of an integrated approach, focusing several streams of investment on the Barr Beacon zone (including non-return valves and reservoir auto valves) in order to maximise benefits at minimum cost.

The Company is also determined to learn more about these assets during the proposed project and will deploy surge monitoring equipment before and after the valves are repaired or removed to better understand if these assets were contributing to surge events within the network. Understanding this will enable asset managers to quantify the existing risks and benefits of future investment for this asset group.

Challenge – CCG, Monson (South Staffs Region)
Challenge the Company to consider surveying and removal, repair or replacement of a small number of non return in AMP6 so the likely risk for mains failure and future costs for dealing with the other non return valves, if then thought necessary, could be established prior to AMP7.
Company Response
The essential investment option has been selected as the optimum delivery strategy as it does target a smaller number of greater risk non-return valves which are located on the trunk mains network of four of the Company's largest water supply zones (WSZ's). For instance, the four WSZ's selected represent at least one-third of the Company's population served. They have significant volumes of water stored at service reservoirs (which can exacerbate the rate of flow from burst mains) that equates to about 65% of all strategic storage for the Company and they also include the top two sections of large strategic pumping mains. Also, one of the four WSZ's has experienced a trunk mains failure recently which may have been attributable (in part) to a faulty/inoperable non-return valve and the failure caused significant damage and flooding to local properties. The scheme strategy of selecting the largest valves (250mm or grater) on a WSZ by WSZ basis has not only provided economies of scale, but is also the most cost beneficial and reduces risk to an appropriate level (as confirmed by IO tool).

3.2.4 Reservoir Auto Valves

The primary driver for installing automated reservoir valves is to mitigate damage to third party property and to reduce the impact upon service to customers as a consequence of strategic trunk main failures.

Strategic zones have been identified where failure of any large trunk mains, in particular those within close proximity of large service reservoirs, will release large volumes of water at high flow rates until such time that either the storage provision has depleted or the failed section of main has been isolated from supply.

The proposed automated valves will enable much quicker isolation of any failures within the strategic zones; reducing the risk to customers, their property and their supplies.

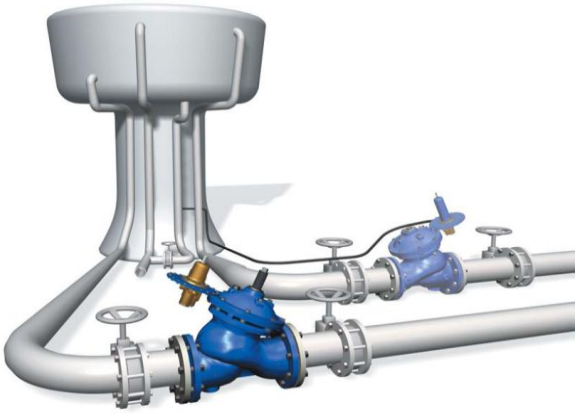


Figure 9: example setup of auto valves
(reproduced with permission of Bermad)

3.2.4.1 Historical Service Delivery

There has been no planned work on existing reservoir valves during AMP5. This scheme is a new initiative to respond to an area of high risk.

3.2.4.2 Delivering Future Service

The following investment scenarios have been considered:

Scenario	Value	Description
Reactive	n/a	
Minimum	£345k	Strategic reservoir and trunk main auto valves: Barr Beacon zone only – to include reservoirs and 36" main
Essential	£640k	As above, but including strategic reservoirs at Sedgley and Outwoods (top 3)
Optional	£1.03m	As above, but also including strategic reservoirs at Shavers End, Gentleshaw and Glascote (top 6)
Premium	£1.29m	As above, but also including Strategic reservoirs at Springsmire and Cawney Hill (top 8)

The investment optimiser has selected the essential scenario from the above proposals. This includes installation of automatic burst control valves on the outlets of the Company's top 3 strategic storage reservoirs (Barr Beacon 1 and 2, Sedgley 1 and 2, Outwoods 2). The essential scenario also includes funding to install three automated butterfly valves at strategic locations along the 36" main between Barr Beacon reservoir and Seedy Mill Treatment Works, allowing remote isolation and control of a high risk section of cast iron main.

The three reservoirs proposed above account for 55% of the Company's strategic reservoir storage, and have also been prioritised because the reservoirs are all sited in high consequence urban/residential areas. As a worst case example, a modelled failure on a 24" main close to the Outwoods reservoirs has indicated potential flooding to an area containing almost 2,000 properties, 2 schools and one railway if the burst is allowed to run for 2 hours before isolation. As an additional benefit, the scenario selected includes work at Barr Beacon reservoir, synergising with the proposed work within this supply zone for strategic non return valves.

3.2.5 Cathodic Protection

Cathodic protection is used to minimise corrosion on some of the Company's most strategic pipelines. This involves the creation of an electrochemical cell, formed between the pipe wall and anodes that are placed within the pipes. This electrochemical cell 'attracts' corrosion to these sacrificial anodes, preventing galvanic corrosion at pipe walls.

Reduced corrosion will extend the life of these expensive pipelines, deferring the need for renewal and therefore reducing the long-term network maintenance cost for customers. Improved condition of the mains will also reduce operational costs due to a reduced number of failures.

3.2.5.1 Historical Service Delivery

The Company will invest a total of £190k on the survey, maintenance and renewal of existing cathodic protection systems by the end of 2014/15. These systems are located within the South Staffs region on some of the Company's most strategic assets, conveying water from one of the Company's primary treatment works at Hampton Loade on the River Severn, up to the urban areas of Sedgley and the Black Country.

The survey work associated with this maintenance activity has found many of the sites are inaccessible because of road traffic or defective chamber lids. Of the cathodic protection installations that have been surveyed, one has been assessed as unsatisfactory condition and requires intervention.

3.2.5.2 Delivering Future Service

The Company intends to maximise the benefit of the intervention activity carried out during AMP5 and is creating a programme of regular inspection and maintenance to ensure that these important systems are monitored.

The investment scenarios proposed for AMP6 are to continue the work on the Company's existing cathodic protection installations, but also to consider new installations on other large diameter steel mains. New installations are being considered due to the very high cost of mains renewal; protecting these mains could provide a more cost effective long term strategy where renewal intervention is deferred.

The following investment scenarios have been considered:

Scenario	Value	Description
Minimum	£428.75k	Surveys of all steel mains > 300mm Refurbishment / renewal of installations where required on HLTW – Sedgley main (accessible sites only)
Essential	£643k	Surveys of all steel mains > 300mm Refurbishment / renewal of installations where required on HLTW – Sedgley main (all sites)
Optional	£1.285m	As above, but one new main to be protected, in AMP6
Premium	£1.2859m	As above, but two new mains to be protected, 1 x AMP6, 1 x AMP7

The Company is proposing the 'essential' scenario from the above list, recognising the importance of maintaining the existing cathodic protection systems, but deferring the installation of expensive new schemes. Survey activity during AMP6 will vastly improve the Company's knowledge about both the condition and the effectiveness of the existing systems. At the end of AMP6, the operation of existing cathodic protection assets will be assured for future AMPs, and a decision can be made (using survey results) for the scaling back or continuation of cathodic protection funding.

Challenge – CCG, Monson (South Staffs Region)

Whether the condition of the Hampton Loade strategic mains warrants the replacement of the cathodic protection system in AMP6.

Company Response

Many strategic utility pipelines are protected by cathodic protection from new. The technique is designed to prevent or slow down corrosion of the pipe walls, thereby preventing future failures and extending the lifetime of very expensive or very strategic assets. Allowing the pipes to deteriorate before applying or maintaining the protection contradicts this strategy and reduces the amount by which asset lives could be feasibly extended. There is little engineering evidence available to show a viable alternative to cathodic protection of steel mains, so the continual assessment and maintenance of those lengths of main already having cathodic protection is felt to be the most sensible course of action at present. Our essential scenario in our PR14 submission allows for resistivity surveys of all trunk mains above 300mm diameter, with a targeted programme of refurbishment, maintenance and analysis of the benefits of installing cathodic protection on those mains not already protected.

3.3 Network Reinforcement

Key Points – Network Reinforcement	
Outcomes:	 Secure and reliable supplies  An excellent customer experience  Fair customer bills
Investment:	Slight uplift from previous AMPs. This is due to aging network and the high value placed on reliable supplies during customer consultation. Still relatively low percentage of overall IP
Proposal:	£2.12m = 1.11% of SSC IP

The Company is responding to the importance that customers place on secure and reliable supplies, a view reflected throughout the customer engagement exercises undertaken during the development of this business plan.

The networks within the South Staffs and Cambridge regions are responsible for delivering 400 million litres of water to a population of 1.5 million customers every day. Maintaining this ability to consistently deliver sufficient flow and pressure at customer taps is an on-going challenge, and an area of service where South Staffs Water and Cambridge Water have historically excelled. The merged Company intends to continue to deliver against this important outcome.

This section of the strategy document outlines the investment required to maintain sufficient 'headroom' within the network to ensure that customers receive adequate water pressure and flows.

The asset managers for the networks utilise highly calibrated hydraulic models to simulate available flows and pressures across the distribution systems, for a range of supply and demand scenarios. This enables the effects of mid-summer peak demand conditions to be ascertained and also enables the impacts of critical asset failures to be measured. The Company has developed these models throughout AMP5, utilising the 'critical point' pressure monitors installed within a large proportion of the district meter areas (DMAs) to ensure that the models accurately reflect the supply conditions experienced by the end users, our customers. Using these models, asset managers are able to accurately identify all properties that are potentially exposed to supply issues during specific supply scenarios; they are also able to model the effects of potential solutions, such as new mainlaying, pressure optimisation or rezoning, to assess which is the most cost effective resolution.

The investment scenarios outlined in the following sections have been carefully considered to achieve an optimal balance of reactive measures (operating costs) and proactive investment (capital cost).

3.3.1 Historical Service Delivery

The Company will invest £2m on network reinforcement by the end of 2014/15. This investment has resulted in the implementation of 37 individual capital schemes, typically installing new mains and valves to improve supplies to areas of the network that are susceptible to supply issues during periods of high demand.

It should be noted that capital investment is used as an option of last resort for resolution of potential supply problems. The Company always uses hydraulic models to simulate rezoning of DMAs or modification of pressure management (where applicable) to resolve problems

using the cheapest, most efficient method. These operational measures are sufficient to resolve the majority of low pressure problems, and have removed approximately 2500 properties from the 'at risk' list for each year of AMP5 to date.

The 37 capital schemes have removed an average of 764 'at risk' properties during each year of AMP5 to date. This has delivered measurable improvements to customer supplies and is an important contributor to the excellent record held by the Company for very low numbers of DG2 (customer pressure) complaints. The implemented operational and capital schemes will result in over 16,000 properties remaining above the Company's minimum service levels during a worst case peak demand scenario.

3.3.2 Delivering Future Service

The capital solutions proposed for the South Staffs and Cambridge regions for AMP6 are designed to continue the delivery of reliable water pressure across the distribution systems. The Company is proposing to continue implementing operational measures as a primary response, but expects that a comparable amount of funding for capital schemes will be required to continue the current excellent levels of service.

The supply headroom within the distribution network gradually decreases over time. This is caused by:

- Internal corrosion of ferrous mains, increasing pressure losses and decreasing flows across the network;
- Gradual changes in water demand – caused by population shifts or industry startups/shutdowns within areas. The Company is currently forecasting increasing population for both regions, by the end of AMP6, as specified in its Water Resources Plan.

The current modelled network conditions, by the end of AMP5, would see 17,000 properties receiving sub-standard pressure during a worst case peak demand event, and 1,985 of these still receiving poor pressure during an average day.

The following investment scenarios have been considered to address these forecast problems:

Scenario	Value	Description
Minimum	£1.4m	Pressure improved above threshold at year end for: 100% of critical point loggers 75% of average day 'at risk' properties 0% of peak day 'at risk' properties
Essential	£2.12m	As above, but with: 100% of average day 'at risk' properties 0% of peak day 'at risk' properties
Optional	£3.22m	As above, but with: 10% of peak day 'at risk' properties
Premium	£5.19m	As above, but with: 20% of peak day 'at risk' properties

The reinforcement schemes delivered during AMP5 were considered sufficient to maintain stable overall headroom within the distribution system. The scenarios proposed above offer different modelled options around the current headroom position – from a 'reactive' position offering no improvements and gradually increasing risk as headroom naturally decreases, to a 'premium' position offering a significant improvement and transitioning supply risks to a much lower level.

Network reinforcement has been carefully modelled to ensure that an optimal level of work is undertaken. The value of investment in this area quickly drops off; with the 'mimimum' scenario only delivering the 'easy wins' with high benefits, whilst the 'premium' scenario also resolves tougher issues in expensive or less populated areas of the network.

As with other areas of investment, each scenario has been appraised using the investment optimisation methodology and the IO tool has recommended the 'essential' scenario. This scenario includes enough investment to address the 'at risk' properties for 'average day' demand conditions over the next 5 year investment period. Although there is no capital provision for preventing additional short term problems during 'peak day events'

This is an uplift of 6% over the AMP5 investment, which the Company deems to be an appropriate increase, responding to customers' requests for on-going reliable supplies by delivering continued sufficient headroom within the networks.

3.4 Network Resilience

Key Points – Network Resilience	
Outcomes:	Secure and reliable supplies An excellent customer experience Fair customer bills
Investment:	This is AMP6 initiative responds to customer support for maintaining reliability of supplies
Proposal:	£881k = 0.46% of SSC IP

The Company has developed a programme of network resilience improvements designed to complement the above proposals for reinforcement. This activity proactively targets assets that pose a high supply risk if they fail.

Supply interruptions are often manageable operationally; with few mains failures causing significant interruptions to customers. The proposed resilience programme focuses on areas of the network that have single feeds, or where there are insufficient alternative supply routes. In these areas of the network, any mains failures can potentially cause longer duration interruptions.

The Company experiences a relatively stable average of 3 hour+ interruptions per burst event as shown in figure 10. This level of interruptions has been reviewed during AMP5 and the Company has used improved hydraulic models to execute criticality analyses; enabling the following investment scenarios to be devised.

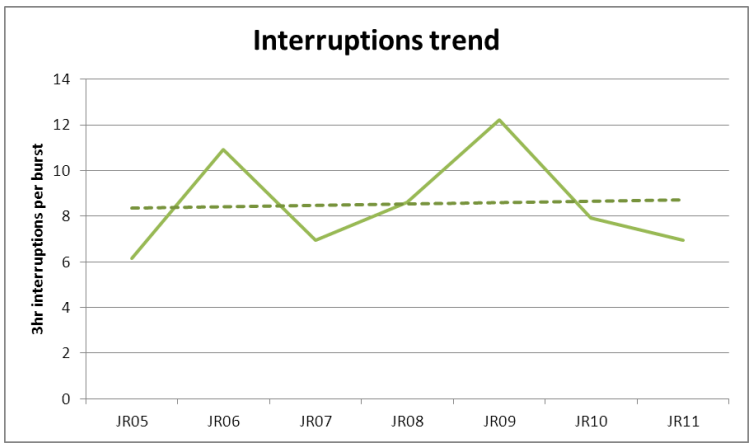


Figure 10: 3hr+ supply interruptions

3.4.1 Historical Service Delivery

The Company currently has no defined resilience funding for AMP5, although there are recognised synergies between resilience and reinforcement programmes, and some areas of low resilience have been addressed because of related problems with network pressures.

Prior to AMP5, the Company has undertaken many network and production projects, aimed at improving resilience of the network (e.g. Sutton Park mains duplication, Wylde Green booster, Kinver to Churchill main).

3.4.2 Delivering Future Service

As with the accompanying network reinforcement project, a complete range of investment scenarios have been developed and compared for resolution of resilience issues. These have been assessed independently for the South Staffs and Cambridge networks, and the two programmes have been summarised in the following tables. The programme for the SSW region is based on specific schemes, bundled into Minimum, Essential, Optional and Premium packages of work for the purposes of optimisation. The programme for the Cambridge region is based on optimisation of 5 specific named projects (optimised in or out of the programme).

The following investment scenarios have been considered for the SSW region:

Scenario	Value	Description
Minimum	£453.5k	Delivery of 2 of 8 named resilience schemes
Essential	£756.24k	Delivery of 6 of 8 named resilience schemes
Optional	£1.134m	Delivery of 7 of 8 named resilience schemes
Premium	£1.512m	Delivery of all named resilience schemes

The following individual schemes have been considered for the CAM region:

Scheme	Value
St Ives Zone	£25k
Eversden Zone	£50k
Cambridge North	£50k
Warboys	£40k
Hayden East	£35k

Each of the proposed scenarios has the potential to improve the resilience of the network over and above the current risk position; therefore each scenario contributes directly to the delivery of the customer outcome for reliable supplies.

The IO tool is very important for assessing this investment group because there are numerous proposals that deliver benefits for supply resilience (e.g. resilience, reinforcement, pressure management and asset renewal); the tool is able to ensure that the strategies recommended are the optimum mix, delivering the required long-term security of supplies at the lowest cost to customers.

The ‘essential’ scenario was selected for SSW investment over AMP6 – this delivers a proportion of the total programme identified and is seen as sensible compromise between cost and improvement to service. Critically for the SSW region, the Sutton Park resilience project is part of this package of work, mitigating the need to renew the existing trunk main. Specific schemes were also approved for ‘Eversden’, ‘Cambridge North’ and ‘St Ives’ zonal resilience within the Cambridge region, the other 2 schemes were optimised out of the portfolio.

This investment is a minor proportion of the recommended business plan (at less than 0.5%) and has the support of the Company's asset managers and CCG because of the reliability improvements for customer supplies. The total proposed programme across both regions totals £881k.

3.5 Trunk Main Renewals – Large PVC

Key Points – Large PVC Renewals	
Outcomes:	 Secure and reliable supplies  Fair customer bills
Investment:	Slight uplift over previous AMP, continuing PVC renewal programme that was started in AMP5. Now proposing split over AMP5, 6 & 7.
Proposal:	£3.4m = 1.8% of SSC IP

The Company is proposing two strands of trunk main renewal work during AMP6; these are to continue the replacement of all large diameter PVC mains (within the South Staffs region) and to undertake selective renewal of large diameter ferrous mains.

The programme of large diameter PVC replacement began at the start of AMP5 and delivers a commitment by the Company to renew, wherever possible, every section of PVC greater than or equal to 9" in diameter within the South Staffs region. These assets were specifically identified in the PR09 business plan because of the high level of risk posed to customer supplies when these mains fail and also due to the prolonged repair times caused by characteristic longitudinal fractures. Where mains are not replaced, then there must be sufficient alternative supply routes to ensure that customers are not affected; this mitigates the risks at a much lower cost to customers.

This programme was originally intended to run for 10 years, throughout AMP5 and AMP6, replacing 40km of assets. Progress during AMP5 has been good, although the work has been much more expensive than was originally anticipated, due to the specific nature of the schemes.

The work undertaken during AMP5 has been chosen based on a risk based approach, prioritising the 40km programme using hydraulic models to assess supply impact and using GIS to assess potential damage to roads and property.

The proposals included below do not change the Company's commitment or justification to replace the entire 40kms of mains. The Company still proposes the renewal (or mitigation where appropriate) of every section of PVC greater than or equal to 9" in diameter. But in consideration of customer affordability, an option to extend this programme over a longer period of time has been analysed and considered.

3.5.1 Historical Service Delivery

The forecasted outturn of the AMP5 PVC programme is on target to deliver 13.6km (34% of the total programme); this includes 11.8km of renewal and 1.8km where risks were mitigated by installing 7 new 250mm valves and rezoning to enable alternative supplies into the area.

As described above, the programme has been prioritised in accordance with a risk based strategy for the asset group. The AMP5 programme is therefore forecast to deliver against the prioritised schemes on the list, targeting 9 from the total list of 61 at an estimated cost of £2.75m. This includes an expensive scheme of 6.3km along a major A-road (A449), yet the programme is still forecast to achieve a reasonable unit rate of £201 per metre.

3.5.2 Delivering Future Service

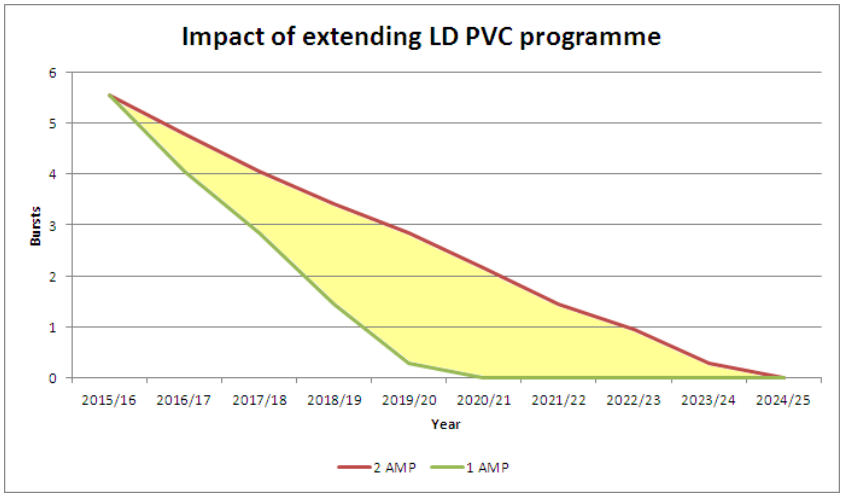
The following investment scenarios have been considered:

Scenario	Value	Description
Reactive	n/a	Defer the remainder of the PVC renewal programme and stand extra risk until AMP7
Minimum	£3.38m	Complete the planned 40km PVC programme during AMP6 and AMP7
Essential	£6.1m	Complete the planned 40km PVC programme during AMP6

The above phasing scenarios have been analysed using the investment optimisation methodology. The Company are still intending to deliver the planned PVC programme at 40km, but have considered the above phasing options to allow the optimisation software to assess sufficient choices to balance bill impact during AMP6.

The investment optimiser recommended the minimum scenario outlined above. This effectively extends the PVC programme for the South Staffs region until the end of AMP7, reducing required expenditure by £2.72m for the AMP6 bill.

This still involves a substantial programme of work, targeting between 13 to 14km of mains across 20 schemes. This is a higher number of schemes and a longer length of assets than that delivered during AMP5. The work is expected to be slightly more expensive per metre, accounting for the additional deployment, design and traffic management charges resulting from the higher scheme count.



The Company supports the selection of the extended strategy because it is more affordable to customers. However, the Company also recognises that stretching the programme over an additional 5 years would result in additional bursts occurring on these assets. This increase is currently forecast at 79% (an extra 11 bursts), indicated by the shaded yellow area on the above chart. As an example of customer impact, this 79% increase translates into a predicted 143 additional 3 – 6hr supply interruptions.

3.6 Trunk Main Renewals – Large Diameter Ferrous

Key Points – Large Diameter Ferrous Renewals	
Outcomes:	 Secure and reliable supplies  Fair customer bills
Investment:	Uplift over AMP5. This is required to target two specific schemes where mains have reached end of serviceable life
Proposal:	£983k = 0.52% of SSC IP

As described in section 3, the Company has revolutionised it's approach to trunk main risk assessment and the consideration of appropriate interventions. These interventions vary in scale from full renewal, through rehabilitation and live monitoring, down to more basic responses such as additional inspections and regular leakage assessments.

The following sections focus on assets where maintenance is not considered to be the optimum solution, and the Company is therefore recommending renewal and rehabilitation interventions.
A total of four schemes were proposed for AMP6, all within the South Staffs region:

Atherstone Street, Tamworth
This scheme renews 1.1km of 1910 12" cast iron main, which has had 5 failures over the past decade. Each of these failures has the potential to trip a nearby booster station if suction pressure cannot be maintained, which could then compromise supplies to around 300 properties.

Because of the strategic nature of this main, and the difficulties of taking it out of supply for the sustained periods of time required by rehabilitation techniques, the only intervention considered is full renewal.

Kidderminster Road, Wall Heath
This 1.5km scheme targets a 24" steel main installed in 1939. This main has had 8 failures recorded during the past 16 years, some of which have caused flooding to local properties. The loss of this main can potentially affect an estimated 2000 properties, 500 of which cannot be fed by an alternative means and so would lose supply.

A recent condition assessment has revealed an estimated remaining life of just 7 years, corroborated by visual inspections reporting heavy external corrosion. This 7 year life does not mean that the asset will deteriorate significantly between now and then, but is an indicator of the remaining structural strength of the asset. Combined with the high operating pressures of up to 180m, the weakened condition contributes to the high probability that this main will continue to fail at an increasing rate.

Rehabilitation techniques have been considered for this main. However the high operating pressure is likely to require a new ductile iron main, excluding any intervention other than renewal.

Sutton Park
An 18" 1962 cast iron main crosses Sutton Park, partly twinned with a new 600mm ductile iron main. This delivers the primary feed into the town of Sutton Coldfield.

Consequences of losing this main are significant, with an estimated 7400 properties initially affected, reducing to 1100 properties if all other feeds into Sutton Coldfield are successfully opened.

Recent condition assessment activity has shown mixed results for the un-twinned sections at the east and west of the park, with one NDT predicting as little as x remaining life. This scheme is one intervention considered to mitigate the risk of this asset failing and would involve the renewal of all 470m of cast iron main. Another scheme being considered under the 'Network Resilience' project is to twin the 470m of cast iron, mitigating the risk by providing an alternative main. Both of these options have been proposed through the IO tool in order to assess and compare the business cases in isolation – the renewal approach reduces the probability of failure of a high consequence asset, whilst the resilience approach will reduce the consequences of failure by providing an alternative method of supply. These two scenarios are mutually exclusive and only one option (or none) will be recommended in the final investment programme.

Brasshouse Lane, Smethwick
This short scheme targets a problematic 300m of 1910 18" cast iron. The main has failed 4 times in the past 10 years and, when it fails, causes damage to third party infrastructure.

The main crosses under a dual carriageway, a railway line and then through the deck of two stone arched canal bridges. The main poses a risk to the safe operation of the railway and previous failures have caused aesthetic if not structural damage to one of the canal bridges.

Two interventions have been considered for this proposed scheme. One would involve relaying the main along an alternative route. The other intervention would involve the insertion of a fully structural PE main through the existing cast iron pipe (assuming sufficient access points can be excavated around other infrastructure). The costs for these two solutions are relatively close (c.£100k difference); for the purposes of investment optimisation a quote averaged between the two solutions has been used.

3.6.1 Historical Service Delivery

The Company has always renewed or rehabilitated large diameter mains only when it can be proven that the assets have reached the end of their serviceable life.

No large diameter ferrous mains were replaced during AMP5 in either the South Staffs or Cambridge regions.

3.6.2 Delivering Future Service

The following investment scenarios have been considered:

Scenario	Value
Atherstone Street	£599.8k
Kidderminster Road	£816.6k
Sutton Park	£383k
Brasshouse Lane	£166.2k

Each of the above schemes were optimised individually, with the IO tool allowed to choose whether to undertake each scheme.

The investment optimisation has recommended that the Brasshouse Lane and Kidderminster Road schemes are undertaken during AMP6.

The Sutton Park scheme has not been selected because sufficient investment has been allocated to target this main under a resilience scheme. The resilience option is considered to be the optimal solution, however it is worth noting that both options had a high benefit to cost ratio.

The Atherstone Street scheme was also assessed with a positive benefit to cost ratio during CBA, but was optimised out of the final investment portfolio when financial constraints were imposed.

The Company is confident that the two selected schemes pose sufficient risk to customer service that they warrant undertaking during AMP6, despite a high cost per metre and the on-going concern for customer affordability. The two schemes comprise just 0.2% of the strategic main network, and require just 0.52% of the funding requested for the overall investment programme.

3.7 Trunk Main Monitoring

Key Points – Trunk Main Monitoring	
Outcomes:	 Secure and reliable supplies  Fair customer bills
Investment:	Higher than in AMP5, where minimal investment was made to trial technology. Proposed scheme is in direct response to risks identified when analysing strategic mains
Proposal:	£750k = 0.39% of SSC IP

This section describes two methods that the Company plans to employ during AMP6 in order to monitor the operation and condition of trunk main assets; Live Monitoring and Leakage Sweeps/Inspection Walks.

3.7.1 Leakage Sweeps / Inspections

It is possible, and cost effective, to estimate the condition of buried assets based upon the number of leaks and failures observed. The Company currently employs several approaches for detecting leaks on trunk mains:

- Desktop leakage assessments – balancing flows from stations against those into district meter areas
- Leakage sweeps – deploying leakage control technicians to survey trunk main routes using leak detection equipment
- Trunk main walks – using customer liaison officers or leakage technicians to walk trunk main routes, looking for visible leaks and inspecting chambers to ensure fittings are accessible and in reasonable condition

Whilst these activities do not require capital investment, they are an important part of the asset management strategy for trunk mains. The Company intends to continue with the above activities, following the risk ranked priorities within the trunk main register.

3.7.2 Live Monitoring

The Company is planning to utilise live monitoring equipment on sections of trunk main which have been assessed as high risk to customer supplies or to the general public. Based upon the analysis work undertaken for the trunk main register, these high risk sections are expected to total 40km.

The live monitoring installations that have been proposed operate in sets of two or more, identifying any changes in pressure, flow or noise. These alarms are then transferred back to telemetry systems within control rooms, enabling operators to respond immediately. When combined with parallel schemes for automated valves, live networks and telemetry

upgrades, this will allow a step change in the ability of the operators to isolate burst mains or respond to other issues. This proposal, by it's nature, also provides operational synergies and enhancements with other identified investment needs, such as reservoir auto valves and live networks.

The costs included in the proposals below include funding for chambers and equipment. It is worth noting that the chambers and under-pressure tappings can also be utilised for other activities such as flow monitoring, under-pressure camera surveys, leakage surveys and live water quality monitoring. The Company intends to maximise the investment for this area by ensuring that the above benefits are exploited.

3.7.2.1 Historical Service Delivery

The Company has invested £40,000 during AMP5 to install the first set of live monitoring equipment within the Hopwas supply zone. This investment has enabled the Company to trial equipment and chamber designs so that accurate costs can be proposed for AMP6.

3.7.2.2 Delivering Future Service

The following investment scenarios have been considered:

Scenario	Value	Description
Minimum	£150k	4km of live monitoring coverage
Essential	£750k	20km of live network coverage, contributing to coverage on all high risk sections over 2 AMPs
Optional	£1.5m	40km of live network coverage, all high risk sections in 1 AMP
Premium	£1.8m	As optional, but with additional 8km of coverage for higher probability, but lower consequence assets

The proposals described in the above table represent a range of options, from monitoring just two supply zones, through to monitoring all high risk and high probability sections by the end of AMP6. As with other investment groups, these scenarios have been optimised by the IO tool and the essential option has been selected.

The essential scenario is designed to cover all high risk sections with monitoring over the next 2 AMPs. This work is split evenly with 20km in AMP6 and AMP7. Approximately 75% of the proposed investment would fund multi-use chambers, whilst the remaining 25% is for the purchase of live monitoring equipment.

3.8 Summary

The above sections describe the Company's reasoning, historic activity, future proposals and selected programmes for the operation, maintenance, development and renewal of it's trunk mains and ancillary assets. These proposals have been developed to manage the long-term serviceability of assets that are expected to operate, with no detrimental impacts on customer supplies, for well over 100 years.

The Company is confident that the optimised programme of work will continue to support the delivery of service to customers throughout and beyond AMP6, specifically the Company's outcome to deliver ***'secure and reliable supplies (now and in the future)'***. The programme also includes projects that will continue to build knowledge of these important assets to support the identification of future investment needs, which is particularly important when considering the high proportion of trunk mains within the combined South Staffs and Cambridge networks.

The following schemes have been selected for inclusion within the final investment programme:

Scheme	Scenario	AMP6 Cost
Trunk Main Condition Assessment	Essential	£300k
Trunk Main Maintenance		
Trunk Main Ancillary Maintenance	Essential	£940k
Pipe Bridge Maintenance	Essential	£796k
Strategic Non-return Valves	Minimum	£400k
Reservoir Auto Valves	Essential	£640k
Cathodic Protection	Essential	£643k
Network Reinforcement	Essential	£2.12m
Network Resilience		
South Staffs Regional Programme	Essential	£756.24k
CAM Eversden Zone	Essential	£50k
CAM Cambridge North	Essential	£50k
CAM St Ives Zone	Minimum	£25k
Trunk Main Renewals Large PVC	Minimum	£3.38m
Large Diameter Renewals		
Atherstone Street	Not included	
Kidderminster Road	Selected	£816.6k
Sutton Park	Resilience	
Brasshouse Lane	Selected	£166.2k
Trunk Main Monitoring	Essential	£750k
		£11.84m

4. Distribution System Renewals

The renewal of smaller diameter distribution mains accounted for almost 80% of the capital expenditure spent on infrastructure assets during AMP5, amounting to a total of £40m.

The requirements for AMP6 have been considered from the bottom up, to ensure that the proposed programme of work is justified on merit and is not just a continuation of a historical programme. For clarity and for clearer optimisation of options, distribution renewals have been separated from trunk main renewal activity for AMP6. Trunk main and large PVC renewals have already been described in sections 3.5 and 3.6.

Mains renewal is the Company's primary tool for managing longer term serviceability of the network. Assets that are at the end of their useful life cannot be sustained with maintenance strategies without continual impacts on customer supplies.

The following sections describe the approach taken for developing the strategies for renewal activity for both the South Staffs and Cambridge regions of the Company.

4.1 Approach

The Company uses a three phase approach for planning renewals activity. A basic overview of these phases is shown in figure 11 and more detail is given in the following sections.

This approach has been completely overhauled during AMP5 in order to empower asset managers to make optimal decisions on renewal strategies. The Company, along with the whole of the industry, continues to learn more about the behaviour of distribution assets as more failure and condition data is collected year upon year. The approach described in the following sections allows this data to be fully exploited, ensuring efficient targeting of investment to deliver long term serviceability of the distribution network.

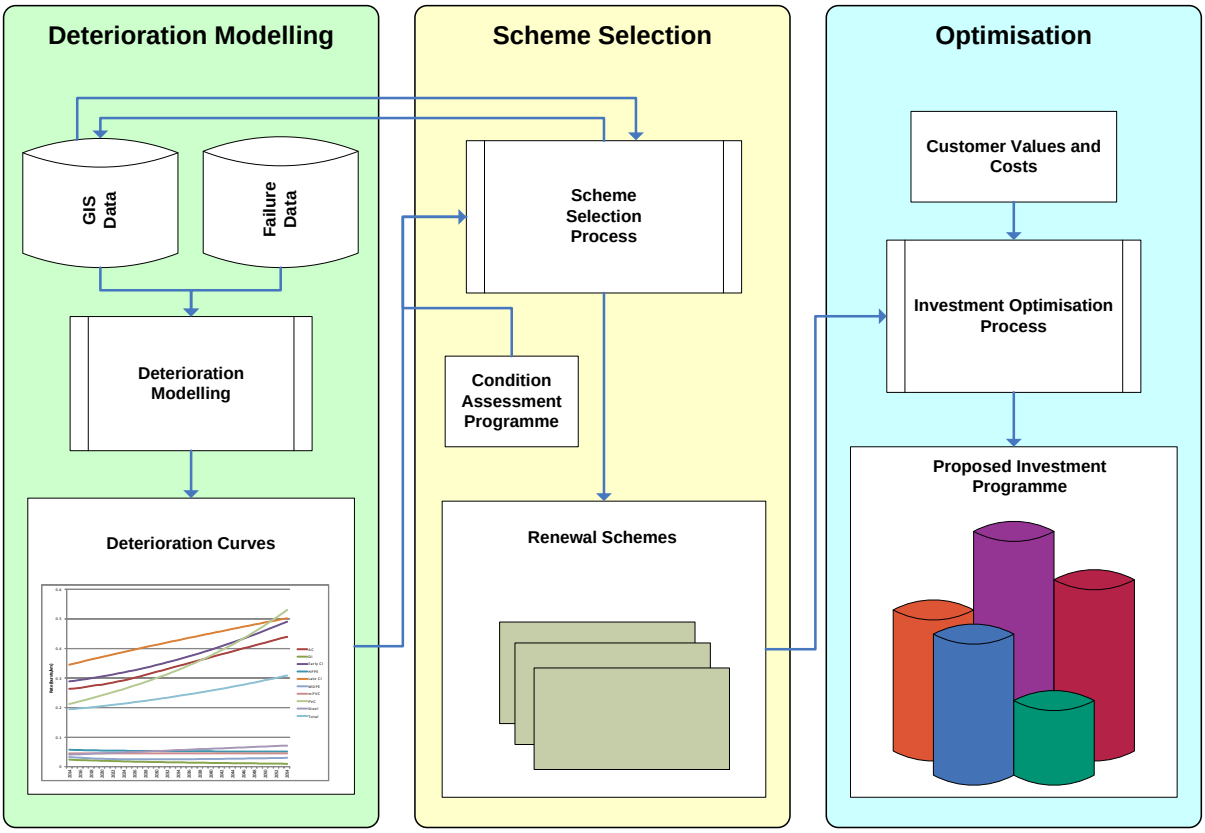


Figure 11: three phase approach for renewals activity

4.1.1 Deterioration Modelling

The asset and failure data held by the Company are considered to be very reliable. With 16 years of failure data now linked to assets for the South Staffs region and 17 years of data for the Cambridge region. This data provides an excellent grounding for producing accurate deterioration models.

Prior to the merger of South Staffs Water and Cambridge Water in April 2013, both companies utilised WRc's deterioration modelling methodology. This has provided a reliable modelling platform for the previous two AMPs and also required that both companies operated similar data sources and processes.

The WRc model has been replaced for the AMP6 proposals in favour of an internally devised set of deterioration lines and curves analysed using the SPSS statistics package. This gives a much more granular suite of deterioration rates, rather than the 4 linear rates in the WRc model. These new models have been developed with statistical assistance and guidance from Mott MacDonald.

Several statistical methods were assessed for constructing these deterioration curves, such as general linear models and standard/weighted least squares regression. Ultimately, a combination of standard and weighted regression techniques were utilised, as these were easier to reapply to the GIS dataset and were also better suited for use where some of the source data was missing (i.e. the early life period of the pipes).

Figure 12 contains a graph showing the data available for deterioration modelling. Despite possessing 16-17 years of reliable data, this is only a short proportion of the total life of the assets that are being modelled.

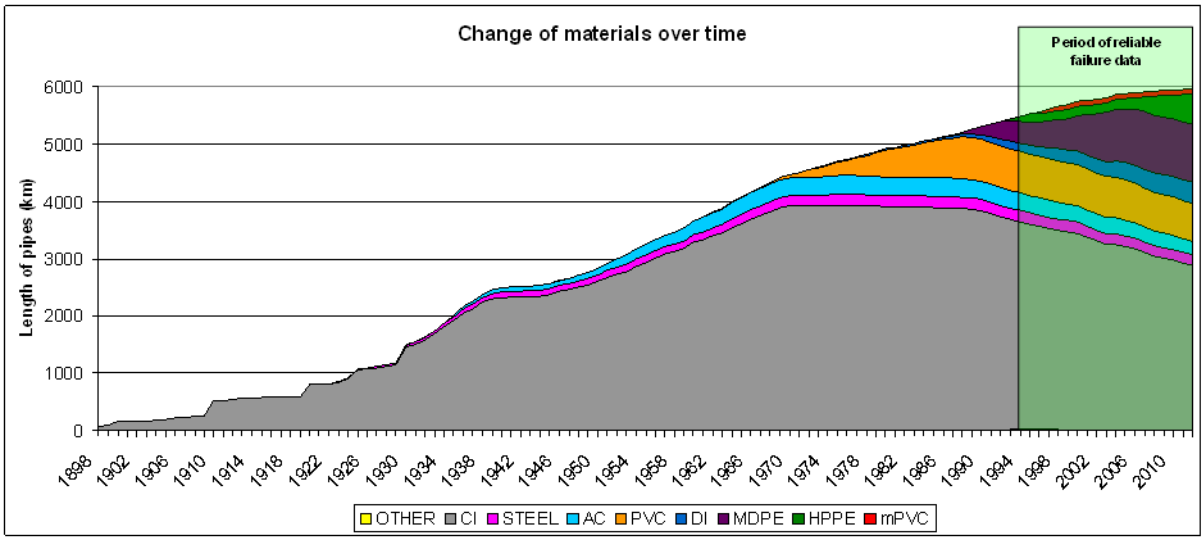


Figure 12: data suitable for use in deterioration analysis

Good statistical models should accurately reflect the behaviour of the assets they represent. Separate suites of curves have been developed for the Cambridge and South Staffs regions because the assets in each area were found to behave slightly differently, probably due to different operating pressures, differences in pressure range stability and differences in the chemistry of both water and soils; all of which would cause the assets to deteriorate at different rates. Overall, the assets in the Cambridge region deteriorate at a slower rate to equivalent assets in the South Staffs region. This highlights the importance of using specifically developed rates, rather than industry standard models developed by third parties. Figure 14 shows the relative deterioration of each region's network when assuming no intervention work is undertaken. The Cambridge region is forecast to experience an average increase in bursts of 0.99% per year over the next 20 year period, whilst the South Staffs region is forecast at 1.36% per year. This is despite both regions having a similar average age of 47.5 years for the Cambridge region and 46.9 for South Staffs, with reasonably close distributions as shown in figure 15.

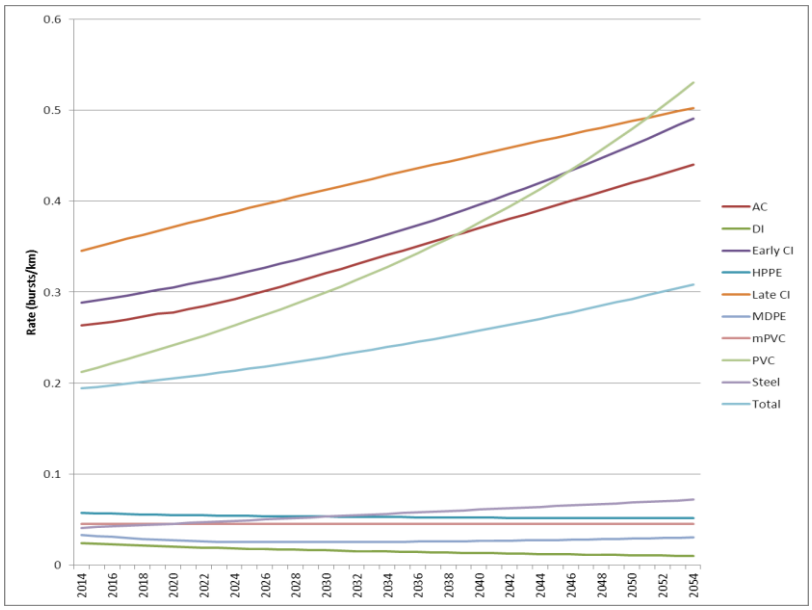


Figure 13: summary of SST deterioration rates

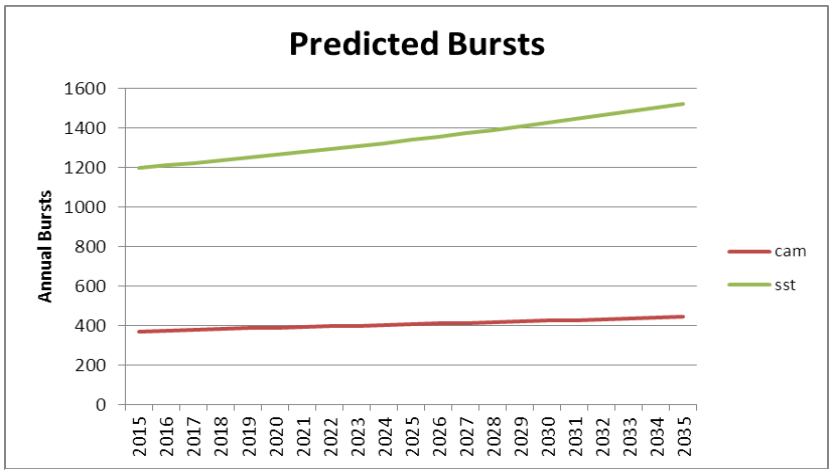


Figure 14: deterioration rates of each region

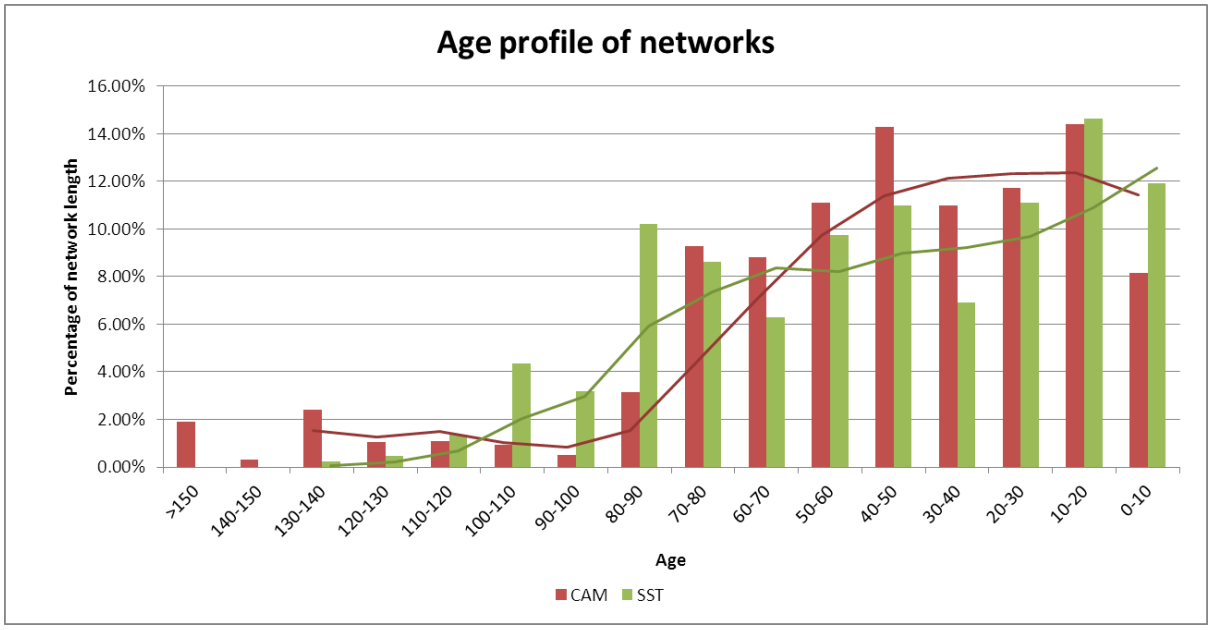


Figure 15: age distribution of infrastructure assets – trend lines are a 3 period rolling average

The statistical analysis and the general approach (modelling through to optimisation) have been appraised by two third party organisations; Mott MacDonald and Seams Analytics. This is to ensure that the approach adopted follows good practice and delivers reliable results that are suitable for both strategic business planning and for day-to-day tactical selection of assets for renewal. Both of these appraisals have found that the work undertaken is 'fit for purpose'.

4.1.2 Scheme Selection

An innovative methodology for selecting renewal schemes has been developed to assist with the development of the AMP6 investment strategy.

Deterioration models are able to rank assets based on their predicted future failure rates. This is useful in its own right, but targeting individual sections of main (or entire cohorts of mains) that are spread geographically right across the Company area of supply is not an efficient tactical strategy for delivering a renewal programme. For this reason, Companies have traditionally separated their tactical decisions (e.g. annual programmes) from strategic decisions (e.g. 25 year forecasts). South Staffs have previously used deterioration models to determine the strategy, how much main needs to be renewed to deliver stable service, and then used alternative techniques such as cluster analysis to determine which schemes to construct within annual programmes. This has inherent risks because the schemes chosen for the annual programmes may not deliver the savings predicted by the strategic model.

The Company's new methodology relies on an iterative process, where algorithms attempt to build schemes out of strings of pipes. An overview of this is shown in figure 16.

By developing a list of 'suggested schemes' rather than simply a list of ranked pipes, asset managers are able to ascertain the burst savings associated with a deliverable programme, rather than the unattainable burst savings associated with individual pipe sections.

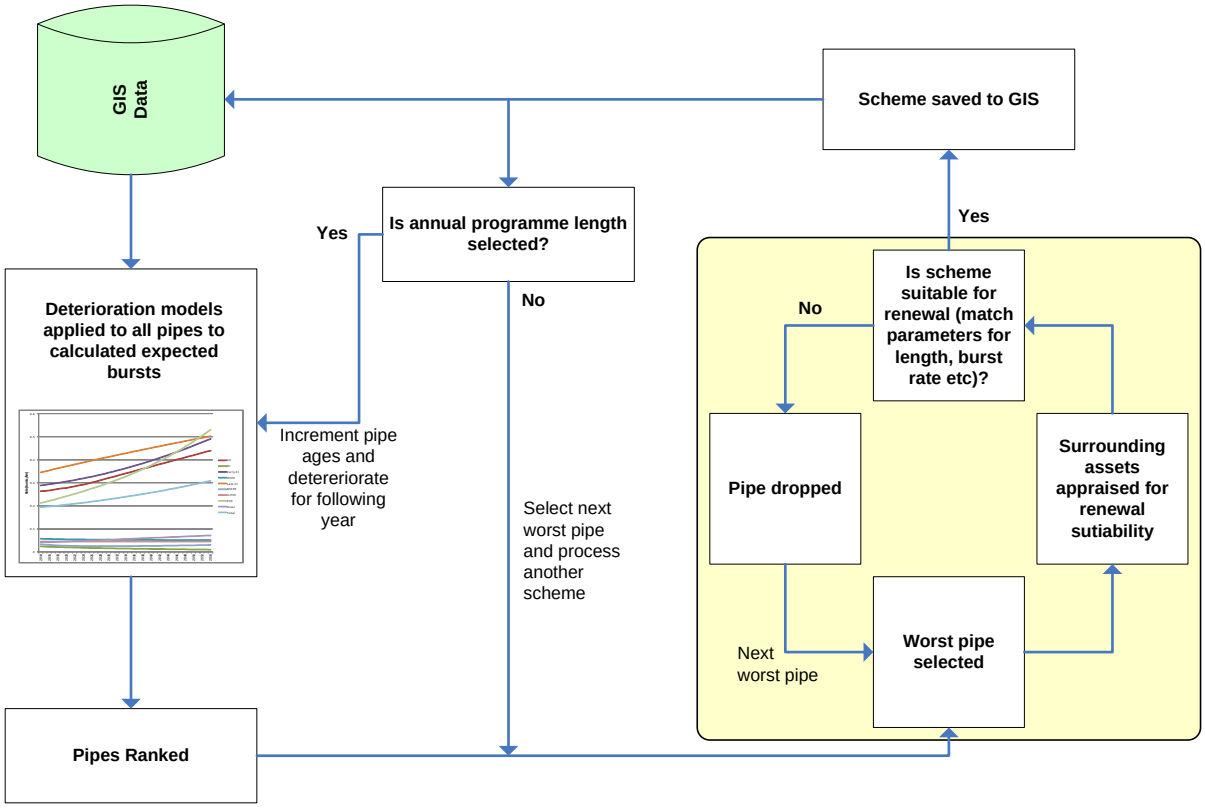


Figure 16: scheme selection process

Another benefit of using the above selection process is the ability to vary the scheme selection parameters, such as acceptable scheme length, to calculate the impact of strategy changes; allowing different delivery strategies to be evaluated within hours, instead of days. This has facilitated the appraisal of many tactical strategies; for example, a comparison of the benefits attained through shorter scheme 'hotspotting' against the benefits of doing larger, more 'engineerable' schemes. This has enabled the Company to ensure that it's proposed annual programmes are striking an optimal balance between renewal scheme costs and scheme efficiency (larger schemes cost less per metre, but typically deliver less benefits per metre).

4.1.3 Optimisation

The proposed renewal programmes for each region have been optimised using the IO tool. However, in addition to optimising the programme against all other schemes, the renewal programmes have also been divided in zonal packages of work, based on discrete water supply zones. This enables each pack to be optimised against every other pack, optimising for cost, burst savings, and most importantly, customer values.

The use of deterioration models naturally optimises the renewal programme, because the pipes selected for replacement are ranked according to their probability of failure. This means that all of the investment scenarios considered will contain a work mix that guarantees the highest modelled burst savings per pound spent. However, the zonal work packages also allow the proposed investment levels to be cross-optimised to account for customer impacts and customer values; this methodology enables the different consequences observed within zones to be utilised when deciding the optimal geographic areas to invest. Fundamentally, this weights the investment to zones where a single burst has higher consequences.

4.2 Small Diameter Condition Assessment

Key Points – Small Diameter Condition Assessment	
Outcomes:	 Secure and reliable supplies  Fair customer bills
Investment:	Slightly less investment than in AMP5.
Proposal:	£148k = 0.08% of SSC IP

Small diameter condition assessment typically involves taking pipe samples by cutting out short sections of main (c. 0.5 metre) and destructively testing to measure loss of bore and levels of internal and external corrosion.

These samples are used principally to support the selection of annual renewal programmes, confirming conditions of mains to ensure that renewal is required. These can be spot checks within zones that are taken in advance of any scheme targeting, helping to build a register of condition grades; or they can be done reactively during the scheme planning/design phase, helping to determine the extents of a scheme (i.e. ratifying decisions to extend/reduce schemes).

4.2.1 Historical Service Delivery

The Company will invest £169,000 on small diameter condition assessment during AMP5. This amount has reduced significantly since AMP4, because improved models and increased period of historic failure data have reduced the reliance on investigative programmes.

4.2.2 Future Service Delivery

The following investment scenarios have been considered:

Scenario	Value	Description
Minimum	£148k	Sufficient samples to support decision making. 25 per year
Essential	£202.75k	Sufficient samples for decision making and continuation of condition grading programme. 35 per year

A reactive ‘do nothing’ scenario has not been considered for AMP6, because this investment, whilst small, is considered an integral part of the renewal programme.

Both of the above proposals were assessed as cost beneficial. The ‘minimum’ option has been selected by the IO tool.

4.3 Small Diameter Renewals

Key Points – Distribution System Renewals	
Outcomes:	Excellent water quality Secure and reliable supplies An excellent customer experience Fair customer bills
Investment:	Lower levels of investment than AMP5. Down by 14.7%
Proposal:	£34.5m; 18.2% of IP

Proposed investment for small diameter renewal activity has been assessed individually for the South Staffs and Cambridge regions, but using a consistent approach, as described above.

4.3.1 Historical Service Delivery

Over recent AMPs the two regions of the Company have operated different renewal programmes. The South Staffs area has invested heavily to achieve stable serviceability in JR08 and maintain that position, whilst lower, but more consistent levels of investment have been delivered in the Cambridge area, maintaining a stable service position.

Figure 17 shows the proportion of network renewed in each region in recent years, against the industry average and inter-quartile range.

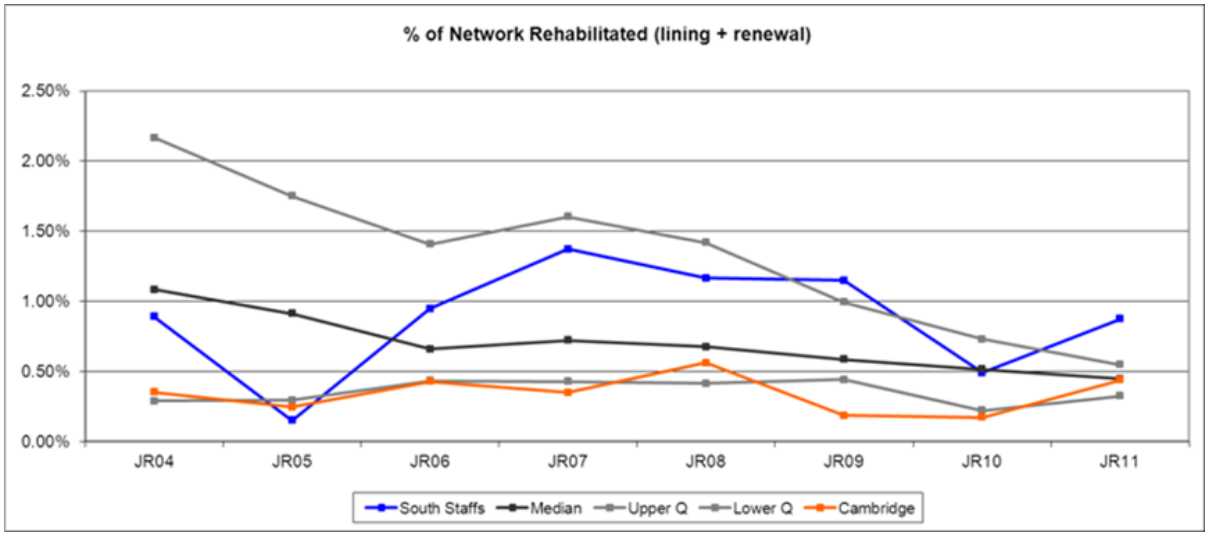


Figure 17: proportion of total network renewed or rehabilitated (against industry reference)

Prior to the merging of the two Companies, both South Staffs and Cambridge had been assessed as 'stable' for infrastructure serviceability. The chart shown in figure 18 shows the recent performance for the burst main serviceability indicator, demonstrating one example of how stable serviceability has been maintained throughout AMP5.

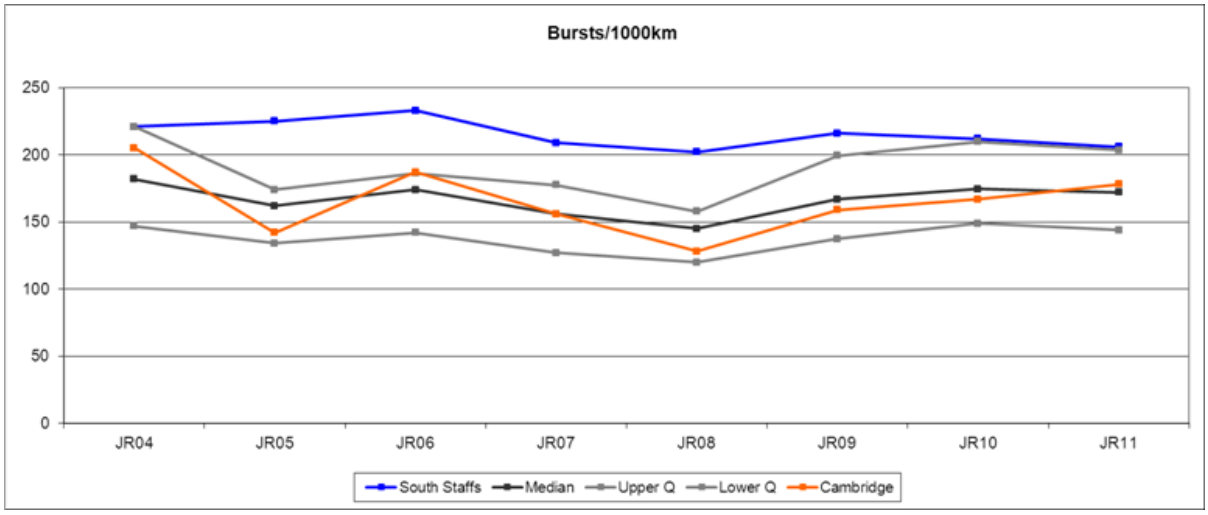


Figure 18: burst mains per 1000km of network (against industry reference)

4.3.2 Future Service Delivery

The Company is determined to sustain stable serviceability, but to also ensure that investment for infrastructure assets is targeted appropriately to ensure that service is delivered in alignment with the values outlined by customers, both now and in the future. The investment proposals detailed in this section are designed to reflect the emphasis that customers have placed upon the maintenance of secure and reliable supplies.

Each of these proposals will be delivered using a similar delivery framework to that employed during AMP5; where schemes are constructed by contractors or direct teams, but where work is assigned in a competitive environment to ensure that costs are kept at minimal levels, and that the quality of work is maintained.

As described in section 4.1.3, the proposals for renewal activity have all been optimised using the IO tool. This involved the presentation of 105 individual workbooks, ranging from 'do nothing' reactive workbooks to premium options for every supply zone. The IO tool was given a choice of selecting any combination of these workbooks, but was constrained to ensure that the overall number of bursts was controlled.

Millions of permutations for renewal were considered before finalising these proposals. This includes considering deferring some or all activity for the next 2 or 5 years to create a more affordable business plan. Deferral of activity has not been proposed in the final plan, because it would cost too much in future investment periods to return the network to it's current level of serviceability.

The graph in figure 19 shows the proposed investment portfolios that have been considered. Each of these proposals has been financially constrained to generate a

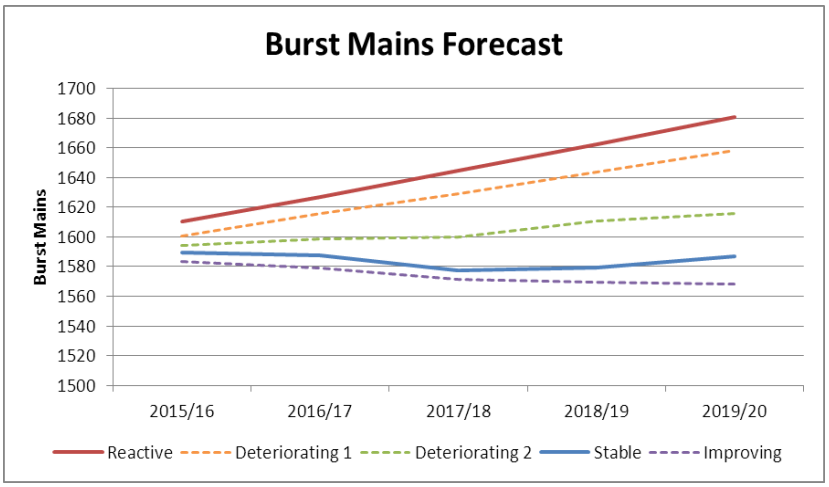


Figure 19: modelled burst mains forecast for combined regions

range of bill impacts. Obviously, a higher bill will generate better service, with a lower bill generally delivering deterioration in service. The IO tool has been allowed to choose the optimal mix of zonal options from the 105 workbooks in order to build the investment for each portfolio. The series shown on the graph represent the combined outputs of the regional deterioration models for the selected renewal work in each portfolio, ranging from a decrease in burst numbers, through to an increase in burst numbers.

The final proposed investment for AMP6 small diameter distribution renewals for the two regions (shown as blue line in the above chart) is:

Value	Description
£34.49m	Delivering an average of 53km of renewals each year across the two regions

This investment is lower than in previous AMPs and has been reduced in order to deliver an affordable investment programme for customers. However, the Company is confident that when combined with other initiatives, the objective of delivering good service to customers and maintaining its stable serviceability assessment is achievable.

The above proposals have been subjected to rigorous internal challenge and specific challenge by the Customer Consultation Group (CCG):

Challenge – CCG, Monson (South Staffs Region)
Whilst accepting that there is justification for replacing 50km of main as planned, but that the expenditure in this high cost area of the investment programme be reduced in AMP6 in order to bring the overall capital cost in that period closer to that in AMP5.
Company Response
This option has already been carefully considered. Extensive modelling work has been undertaken to determine the amount of small diameter renewal work required to maintain future stable serviceability. Dozens of options have been considered, ranging from 30km per year up to 100km per year; these options have also considered investment profiles designed to minimise spend in AMP6/7, and increase at a later date. The Company is confident that the scenarios presented to the IO tool are sufficient to cover a sensible range of options; from decreasing serviceability, through to the premium scenario which improves serviceability. The IO tool is then able to choose between these options independently for each of the 20 supply zones using the benefit valuations determined through Customers' willingness to pay. There is a concern that reducing the renewals spend too far could result in the Company regressing to a position of unstable serviceability; this would have a noticeable impact on Customers and would require future increases in spend to counteract. As a guide, modelled scenarios where 15% of expenditure is deferred from AMP6/7 into AMP8/9 has an impact of 30 bursts per year by 2025.

Challenge – CCG, Monson (Cambridge Region)
Consider factoring into the lengths of main to be replaced an assessment of the number of customers affected should a burst occur on an individual main so to maximise the benefit to customers from the investment. Look at the effect of capping the cost of mains replacement to the figure of £6m as invested in AMP5.
Company Response
This is considered as part of the scheme selection and prioritisation. Through scheme design, numbers of properties affected by future asset failures are addressed by the installation of additional valves etc, to minimise the impact of future shut offs.

4.4 Summary

Network renewal activity is vital for maintaining serviceability of the distribution network, contributing significantly towards the achievement of two of the Company's key outcomes: **'secure and reliable supplies (now and in the future)'** and **'excellent water quality (now and in the future)'**. The achievement of both of these outcomes has strong support from customers and the Company has strived to ensure that current levels of serviceability are continued.

The proposals for AMP6 are to reduce the overall amount of renewal activity, whilst still maintaining current service and delivering responsible long term asset stewardship. This is a challenge for the Company, but it is achievable. As presented throughout section 4 of this document, the Company has collected more asset data, analysed this data to develop better models and utilised these models to create a robust management strategy that will enable the Company's networks to continue to deliver the levels of service that customers expect and value.

This renewal strategy has been considered alongside the entire portfolio of projects proposed by the Company and will combine with other strategies to deliver serviceability, such as on-going network flushing, maintenance and improvement of pressure management, live network implementation and network resilience improvements.

5. Leakage Management

Key Points – Leakage Management	
Outcomes:	 Secure and reliable supplies  Operations which are environmentally sustainable  Fair customer bills
Investment:	Comparable with AMP5 – ensuring that sustainable economic level of leakage (SELL) is delivered at least cost, providing security of supplies, maintaining assets and delivering social and environmental sustainability
Proposal:	Short run/leakage control & repairs = delivered through opex Long run/asset maintenance = £7.81m = 4.1% SSC IP

The Company acknowledges that leakage is an important issue for customers and other stakeholders, as well as the wider environment and community. A key Company objective is to operate in line with the sustainable economic level of leakage (SELL) targets

The following section describes the leakage strategy, asset maintenance requirements and target setting for SSC.

5.1 AMP5 Leakage Performance

AMP5 to date has seen markedly different weather conditions that have impacted significantly on the level of leakage reported. The winter of 2010/11 was extreme, resulting in a significant rise in leakage. The following two years in 2011/12 and 2012/13 were characterised by generally benign winter conditions. 2011/12 was dry, with drought conditions across some areas of the UK. In 2012/13, wet weather limited the leakage breakout during the summer, the subsequent winter was longer than normal but not as harsh as the 2010/11 event.

The reported leakage for both regions over the last five years is shown in the table below, together with the regulatory targets (in Ml/d).

Region	2008/09	2009/10	2010/11	2011/12	2012/13
CAM (Target)	14.00	14.00	14.00	14.00	14.00
CAM (Actual)	13.95	14.17	13.68	12.39	12.36
SST (Target)	75.00	75.00	74.40	74.40	74.40
SST (Actual)	74.25	74.43	72.83	68.17	65.25

5.2 AMP6 SELL Methodology

Both regions have assessed the SELL using regional specific data, but with a common methodology and review process to provide a consistent approach. This is in line with the guidelines set out in the Review of the Calculation of Sustainable Economic Level of Leakage and its Integration with Water Resource Management Planning and the respective Water Resources Management Plans.

The PR14 SELL assessment has been further enhanced by the use of a Company specific relationship between leakage management costs and the level of leakage. Beal Consultants were used to provide general support and challenge, as well as an overall review of the data and approach taken to ensure the assessment was robust.

The analysis takes into consideration external factors such as social and environmental impacts and the cost of carbon.

Leakage is an area of interest for customers, and the Company has engaged with its customers to ensure their views have been incorporated into the AMP6 Leakage strategy. Leakage is linked closely to the following outcomes for customers.

Secure and reliable supplies

Operations which are environmentally sustainable

Fair customer bills

Customer engagement included a presentation and discussion with the CCG on the concept of the SELL, along with wider customer engagement. Customer valuation of leakage through Willingness to Pay surveys included maintaining leakage at the SELL or current regulatory targets and options to reduce leakage to lower levels. It was not considered appropriate to allow leakage to rise, as this would lead to higher bills and impact on the environment and available water resource headroom.

Leakage is one of the top priorities for reduction when considering the views of uninformed customers that were surveyed. This was a feature of both household and non-household customers. However, in the context of wider supply and demand, with the SELL described as a 'tipping point' at which reducing leakage further costs more overall, only around 1 in 4 informed customers supported reducing leakage beyond the economic level.

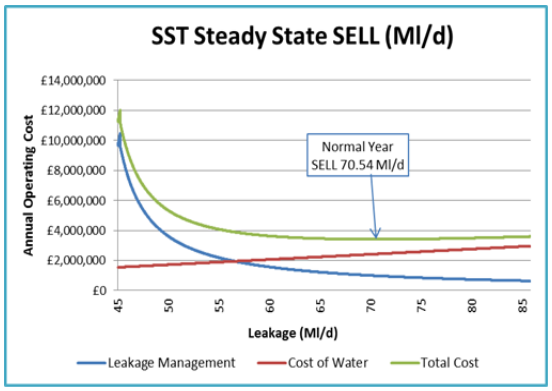
The valuation of customers' willingness to pay for specific enhancements must be considered in the wider scale context of affordable bills. Overall there is general support for leakage to be reduced below the SELL, but this is offset by other concerns related to security of supply and affordable bills. Although a reduction in leakage below the SELL was one of the areas informed customers still supported improvements, fewer than one in ten were willing to pay more to deliver the improvement, or sacrifice other levels of service in order to accommodate this.

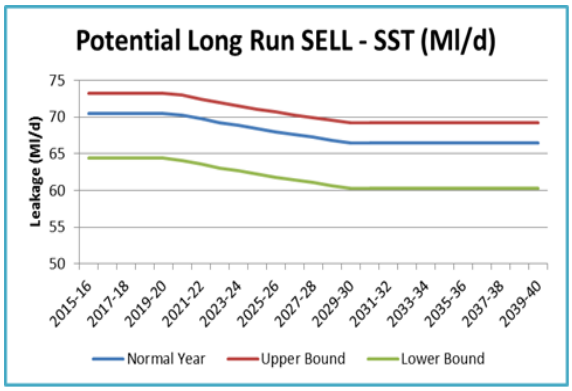
5.3 Sustainable Economic Level of Leakage

The steady state SELL for the SST region for a normal year is 70.54 Ml/d, and represents the lowest total operating cost, as shown in the chart below. An extreme winter event would add an additional 2.71 Ml/d to this, and would be expected to occur on average once in every ten years. As a result a fixed leakage target to cover all expected weather impacts for AMP6 would be 73.25 Ml/d. This is 1.15 Ml/d lower than the current AMP5 target of 74.40 Ml/d.

However, it is proposed that the SELL is set as a range for AMP6, rather than a fixed target, to enable lower leakage targets for normal years and more efficient operations. On this basis, SST would expect to achieve a leakage level of 70.54 Ml/d for a normal year, while using the impact of different weather scenarios on the level of leakage, the upper bound of this range would be 73.25 Ml/d and the lower bound 64.36 Ml/d.

Taking a longer term view, a range of factors such as network deterioration, population growth, increased metering penetration, cost of carbon, pressure management, and mains renewal have been considered to understand their impact on managing leakage. The net forecast effect of these is presented in the chart below and represents a potential reduction in the economic level of leakage in the future, outside of the AMP6 period, due in the main to the forecast cost of carbon.



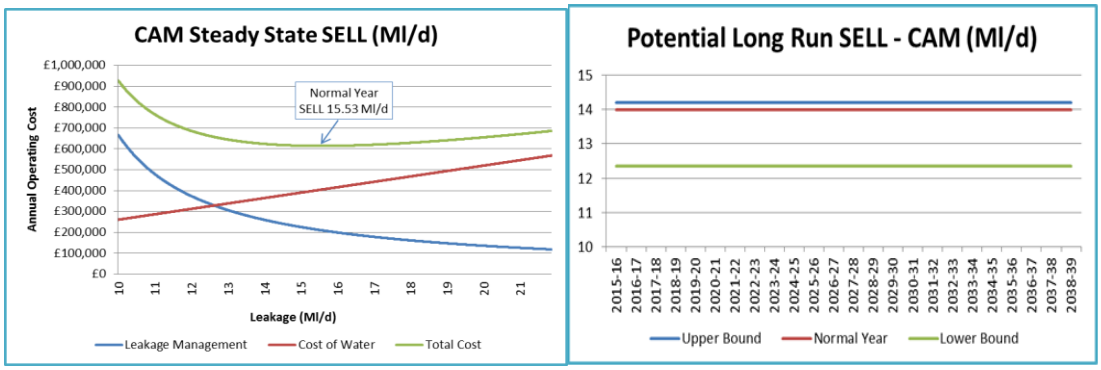


In the CAM region the current regulatory leakage target of 14.00 Ml/d is significantly below the latest assessed SELL of 15.53 Ml/d. As it would be inappropriate to allow leakage to increase in AMP6, the Company is proposing to target a leakage performance commitment of 14.00 Ml/d, but recognises that as a result of the impact of extreme weather it is also appropriate for leakage levels to vary above or below this target, on occasion, to maintain efficient operations.

To efficiently manage this variation the Company is proposing to set a leakage target range, with upper and lower bounds based on weather impacts, around the performance commitment. However, the Company would, on a long term average, expect to report leakage at or below the performance commitment of 14.00 Ml/d.

As the performance commitment is already below the assessed SELL, an upper bound leakage target of 14.20 Ml/d is proposed. This is considered appropriate, as it is below the SELL, and minimises the need to operate even more uneconomically to provide excessive headroom to cover for extreme winter events. The lower bound target of the range is proposed at 12.36 Ml/d, in line with the low levels that can be achieved economically with more favourable weather conditions.

In terms of a long term view, as the current target is below the SELL, analysis indicates there is no scope for further economic reductions, as shown in the chart below. This will however be kept under regular review to ensure this remains appropriate, especially if there is any change in supply demand balance headroom or operational costs or benefits.



5.4 AMP6 Strategy

The Company's strategy is to manage leakage at or below the SELL. For the SST region the strategy is to manage leakage at the SELL. In the CAM region, as the level of leakage is already below the SELL, the strategy is to prevent it from rising above the proposed performance commitment based on the AMP5 regulatory target.

Leakage management is an important issue for customers and other stakeholders. As a result this was widely discussed as part of the Company's customer engagement activities to establish future customer priorities as part of the overall PR14 process.

Whilst customer research identified a desire and general support for the Company to operate at lower levels of leakage, particularly when this subject was discussed in isolation, when considered in relation to the overall impact on the bill, they were unwilling to pay for reductions due to wider affordability concerns.

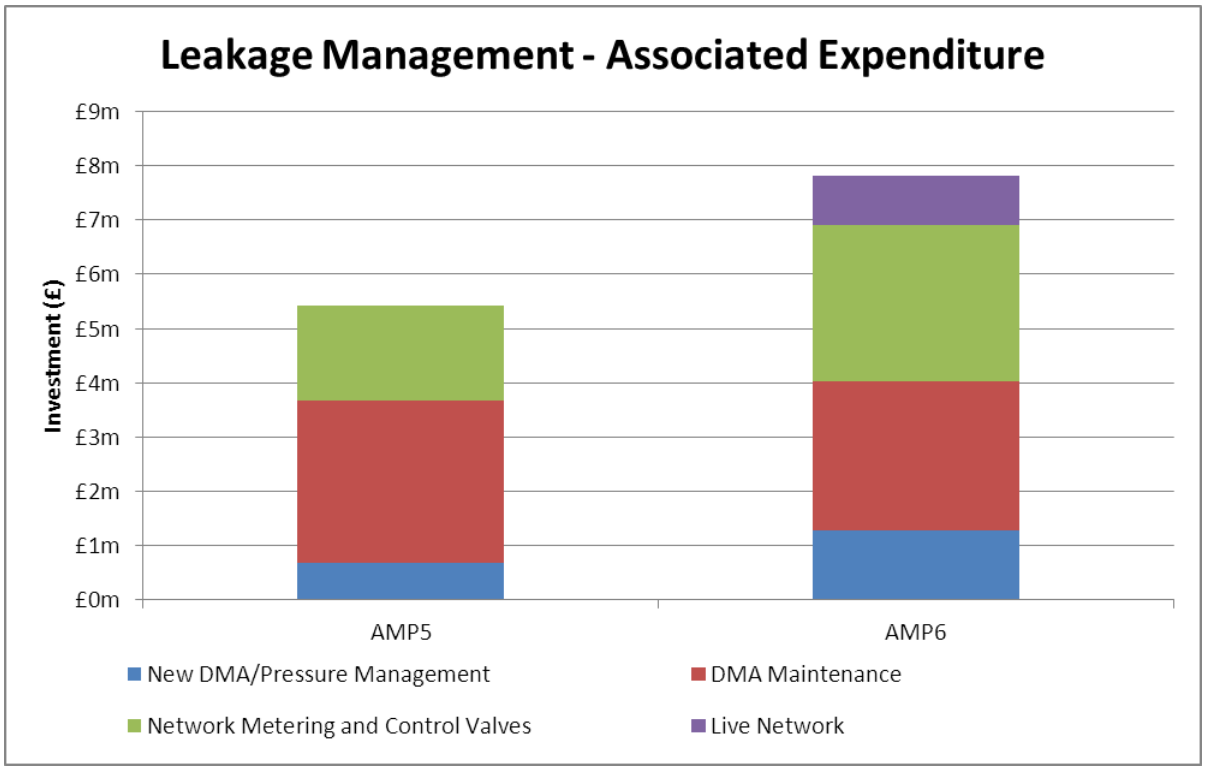
Neither region is forecasting a water resources headroom deficit over the next 25 years. Therefore, there is no economic driver to reduce leakage further over AMP6.

There are however a number of schemes that are considered essential for the on-going delivery of the SELL and to provide increased knowledge to support further sustainable leakage reductions in future AMP periods. These relate to the maintenance and development of DMA and PRV assets. A range of options have been considered to identify the optimum level of investment in this area, using the IO tool, with final proposals identified in the table below.

Area of Investment	SST	CAM	TOTAL
New DMA/Pressure Management	£1,120,000	£160,000	**£1,280,000**
DMA Maintenance	£2,474,000	£268,288	**£2,742,288**
Network Metering and Control Valves	£2,893,000	N/a	**£2,893,000**
Live Network	£747,000	£150,000	**£897,000**
	£7,234,000	***£578,288***	**£7,812,288**

5.5 Leakage Asset Maintenance – Investment Summary

Historically, the Company has focused leakage asset investment to establish DMA's and pressure management. Whilst the expenditure on this area is now lower, as there is a shift towards maintenance of these key assets, there is investment forecast over AMP6 and AMP7 to provide improvements to metering upstream of DMA's, to enable a more robust assessment to be made of leakage on trunk mains and service reservoirs.



AMP 6 Area of Investment	SST	CAM	TOTAL
New DMA/Pressure Management	£1,120,000	£160,000	£1,280,000
DMA Maintenance	£2,474,000	£268,288	£2,742,288
Network Metering and Control Valves	£2,893,000	N/a	£2,893,000
Live Network	£747,000	£150,000	£897,000
	£7,234,000	***£578,288***	**£7,812,288**

The costs for AMP5 are current costs, and AMP6 costs are not inflated in the data shown above. The key points to note are:

- There was significant investment in establishing new DMA's and PRV's in AMP4. This has reduced for AMP5 and AMP6 as DMA's that are inefficient for ALC are focused on, along with further pressure management of existing areas (e.g. through installation of 2nd reduction PRV's).
- There was less expenditure on DMA/PRV capital maintenance in AMP4 due to the fact that there were significant programmes setting up new DMA's.
- The level of expenditure on DMA/PRV maintenance has reached a relatively constant level seen in AMP5 and AMP6.

- There is uplift in expenditure on Network Metering and Control Valves forecast, as it is becoming more important to assess leakage upstream of DMA's, and improvements are required in metering in order to be able to identify areas for active leakage control, to tackle trunk mains and service reservoir leakage efficiently and effectively in the future.

- There is a new area of investment, in live networks. This is not solely related to leakage management but is one of a number of drivers. This is focusing on how technology and innovation can integrated and used to improve leakage, asset, network management and also deliver benefits in terms of customer services.

5.6 Leakage Asset Maintenance – Technical Summary

The following is a high level technical summary of asset maintenance and long run schemes associated with leakage management.

5.6.1 DMA Replacements

The Company's DMAs form the core tools for effective and efficient targeting of resources and investment in both SST and CAM regions, with 523 DMAs in SST and 93 DMAs in CAM. Data is collected from 99.66% in SST and 100% in CAM, of DMAs daily or more frequently. This data is used to target DMAs for active leakage control (ALC) intervention. DMAs are managed reactively.

In general each active leakage control is undertaken in each DMA at least once every 12 months. Data from DMAs is used to carry out more reactive interventions as and where required, and to maximise the efficiency and performance of available ALC resources.
Following a significant programme of investment to implement DMA's in AMP3 and AMP4, DMA's are installed to a standard specification. This provides where practical:

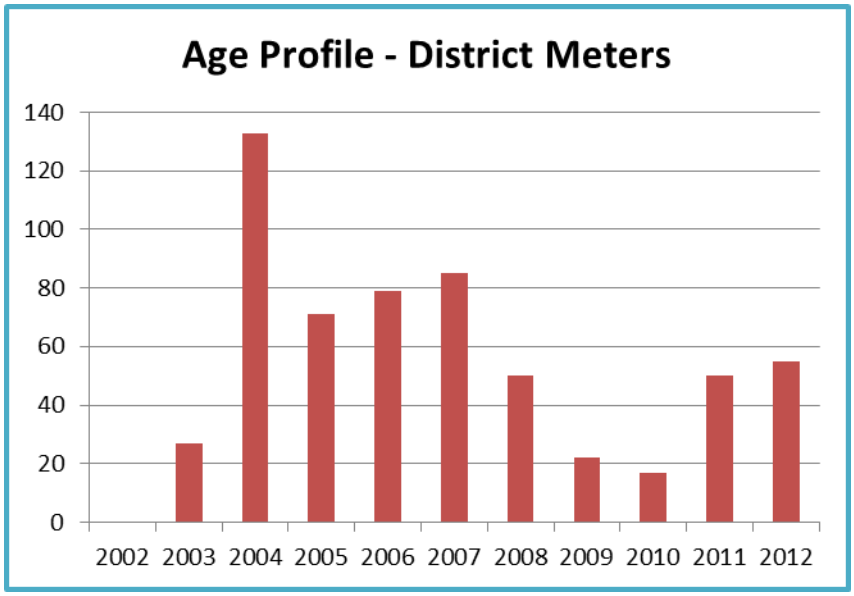
- Pipework specification with straight lengths of pipe ten times the meter diameter upstream of the meter, and five times the meter diameter downstream of the meter. Independent meter testing carried out for The Company by TUV NEL supports this specification as installation of bends or tapers can lead to error.

- Where practical and feasible DMA's are installed in footpath or verges to allow for safer access for maintenance of meters or data loggers.

- Where possible pipework has been elevated to provide a shallow chamber to reduce the risk posed by staff entering confined spaces.

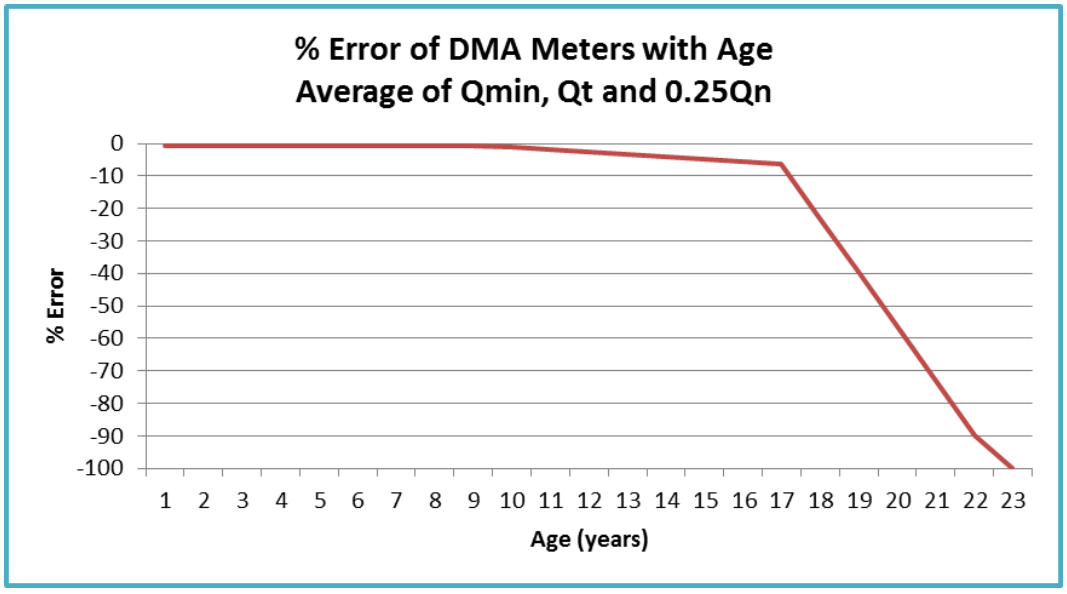
- The chamber design and location facilitates meters being exchanged for relatively low cost within the existing chambers. This is considered important in terms of whole life costing to enable meters to be replaced when required.

The age profile of District Meters in SST is shown in the chart below. In the context of the standard specification described above, whole life costing favours the installation of mechanical meters. There are circumstances such as low flows, or where meters cannot be installed in the verge or footpath that electromagnetic flow meters are installed for technical or practical reasons. Of the asset stock for District Meters, 91% are mechanical and 9% are electromagnetic. This proportional split is not expected to change significantly in AMP6.

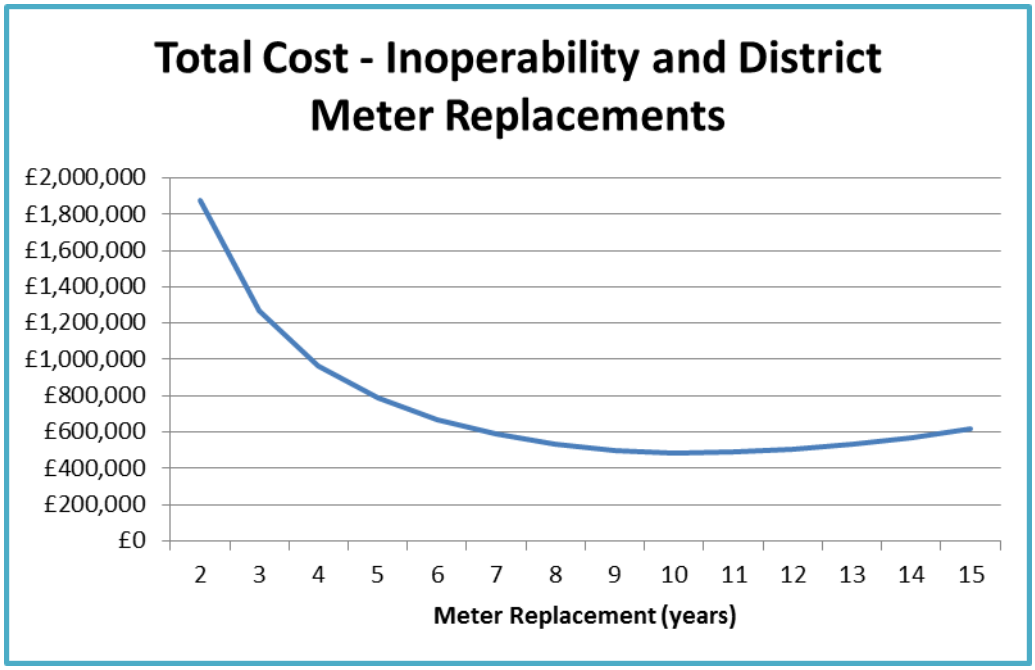


Mechanical meters do wear out over time. In AMP4 and AMP5, independent meter testing has been carried out by WRc NSF and TUV NEL to assess the performance of District Meters removed from service. The Company has tested 48 district meters in AMP4 and AMP5 to date to support the identification of an optimum District Meter replacement strategy.

The lower flow points of the meter are of the most relevant in relation to leakage management. Using the three lowest test points from independent meter testing, and typical DMA flow profiles, the % error associated with flows likely to be recorded for estimating leakage are able to be assessed.



Without investment in this area, the loss of accuracy of District Meters would over time render DMA assets inoperable. This results in reduced efficiency and effectiveness of targeting for active leakage control activity. The cost of inefficient active leakage control activity and the cost of replacing DMA assets when considered in terms of total cost indicates that in SST replacing meters proactively at around 10 years provides the optimum meter replacement strategy.



In terms of these assets, there is not considered to be any significant risks of changes to affect this long term capital maintenance strategy. Alternative that could be considered are either not cost effective (ultrasonic measurement), not accurate enough or not practical in the case for installation in existing chambers in the case of Insertion Probes.

5.6.2 DMA Improvements

In the Cambridge region, the focus in terms of long run SELL investment is to tackle inefficiency in an existing oversized DMA. Bluntisham Tower contains one DMA of 9034 properties, with on average 152 leaks found per annum. This is taking 37 hours per leak compared to 13 on average in CAM, therefore investment is proposed to split this oversized DMA. The proposed solution is to create 6 new DMAs from the installation of 10 new district meters. The long run investment proposed is aimed at mitigating any increase from the currently below SELL regulatory target.

In the South Staffs region, this investment relates to two core functions:

1. Splitting DMA's that are considered oversized or have a high ratio of mains length to properties, to improve operational efficiency
2. Providing improvements in data on household night use and consumption through individual household monitoring at a high frequency and resolution of small micro DMA's.

The average DMA size at 2013 is 1080 properties. A summary of DMA characteristics including property count, mains length, material/cohort, leakage, ALC hours, and number of jobs by type was analysed. This data was used to identify DMA's where there were high numbers of jobs per unit length of main or ALC was inefficient, and the DMA's would benefit from splitting further. The majority were where property counts were significantly above average.

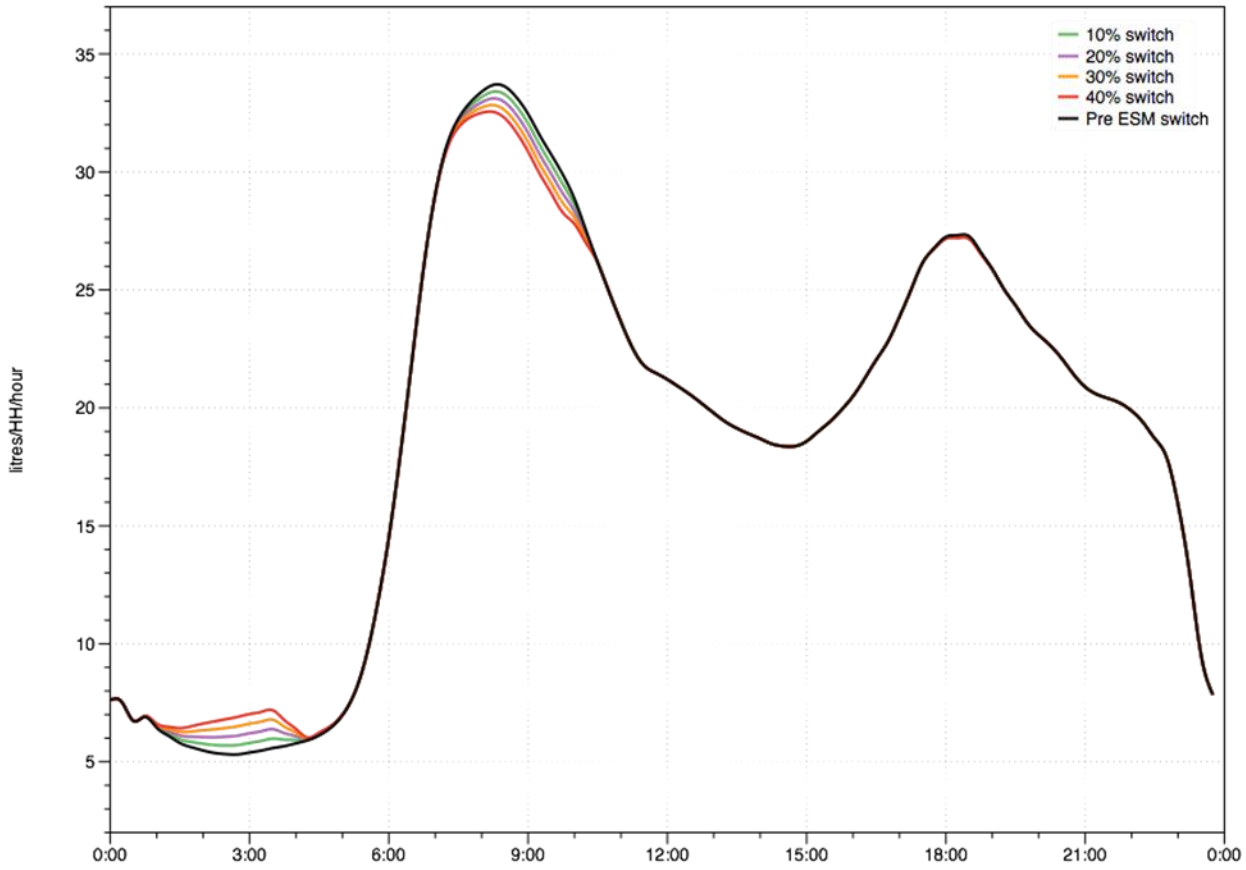
The second core function requires improved measurement of household night use, due to a number of external factors that are considered to have changed over time, or are at risk of changing over the next few years:

- Night use during religious periods or festivals as society becomes more diverse culturally
- Holiday periods
- Horticultural seasons, that may be affected by Climate Change
- Smart Meter roll out for 30 million homes and small businesses for energy by 2020. Associated tariffs could drive more night use of white goods appliances that utilise water during the MNF period.
- Changes in agricultural practice
- Changes socially – shed bedding, bed sharing etc.

From analysis carried out by Mease for SSW, it is already apparent that there are significant variations temporally and spatially from seasonal analysis of Socrates data:

	Socrates Method						Effective min method		
	Jan-07	Feb-07	Mar-07	Jan-12	Feb-12	Mar-12	Jan-12	Feb-12	Mar-12
	HHNU l/p/h								
D179	2.16	2.03	2.03	2.85	no data	1.85	2.70	no data	1.81
D177	1.22	1.22	0.90	1.32	1.62	1.44	1.20	1.34	1.22
D270	0.35	0.36	0.30	1.81	3.71	1.90	1.64	2.82	1.58
D590	1.92	1.98	No Data	2.21	2.27	2.03	2.00	2.05	1.82
D301	1.78	2.14	1.68	1.42	1.82	1.56	1.15	1.51	1.27
D656	3.17	4.99	3.72	3.50	5.43	3.02	2.76	5.28	2.73
D559	2.86	3.11	No Data	3.73	4.88	3.42	3.43	3.85	2.97
D281	No Data	No Data	No Data	1.67	1.71	1.61	1.60	1.64	1.48
ave.	1.92	2.26	1.73	2.31	3.06	2.11	2.06	2.64	1.86
% increase in		24.00%			38.60%			34.70%	

Variability of HHNU

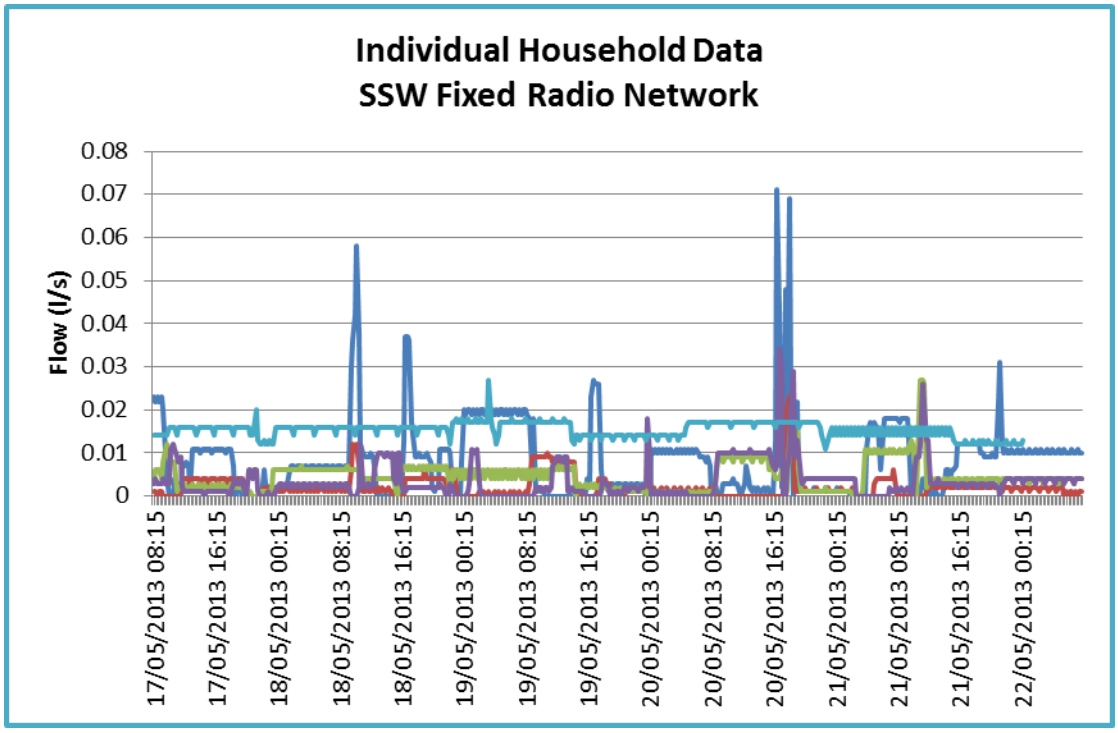


Potential impact of ESM switchover increasing use of 'white goods' products during the night

The above chart indicates a relatively conservative view of the changes that could occur as early as AMP6 with the roll out of energy smart metering that could change energy and water consumption patterns. The increase could easily result in an increase of the order of magnitude of several Ml/d increase in leakage without improved measurement. It was therefore determined that a combination of the following would be required to mitigate this and other factors that are seeing changes in night use. The existing Socrates technology is becoming obsolete in AMP5, so a series of trials and projects are underway:

- Two fixed radio network trials to collect 15 minute individual household data from around 250 properties
- Fast logging and pulse interval timing is being carried out in tandem with Socrates data collection, using GPRS data loggers.

The risk of not investing in DMA Improvements to split DMA's where required, and to improve the tools available to measure night use and consumption is that with an inadequate approach, resource may be deployed inefficiently or regulatory targets may fail to be achieved. This scheme is linked to Data Loggers and PRV Controllers, as that scheme will provide the vehicle to potentially provide a fast logging solution on many/all DMA's. A project is underway to establish a way forward. This DMA Improvement scheme provides investment in further individual household monitoring on a series of micro DMA's to ensure night use is properly measured in the context of leakage management and reporting.



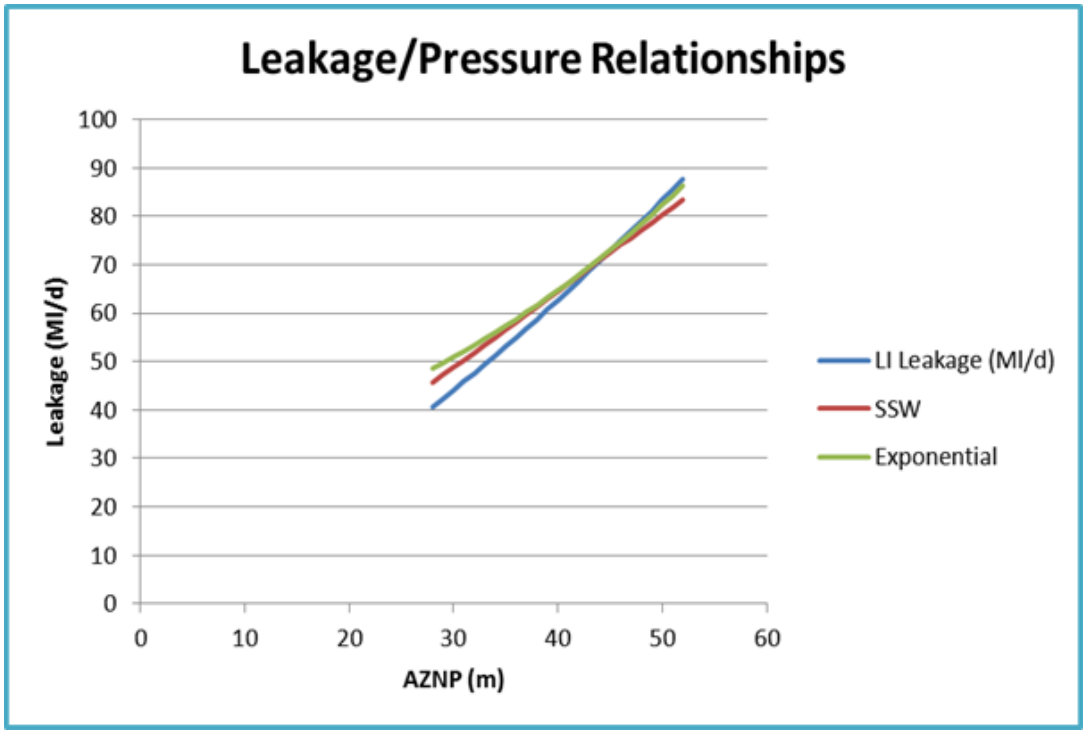
Example of individual household data collected from radio network trials

The splitting of DMA's and improved data to measure night use at a DMA level is considered adequate to offset the risk associated with apparent leakage increases in AMP6 due to changes in night use and behaviour. Further data collection over time and in particular from the AMP5 fixed network trials, and the proposed Live Network scheme in AMP6 will enable improved assessment and quantification of these risks.

Initial results from a long range radio trial in Kinver has proven to be successful and reliable in terms of gathering data from underground from a single mast a considerable distance from the DMA. The read interval success on a daily basis is generally around 99.5%, giving some confidence that the technology could offer long term benefits both for improved understanding of night use and consumption, but also having the longer term potential to identify hidden customer side leakage significantly more quickly.

5.6.3 New Pressure Management

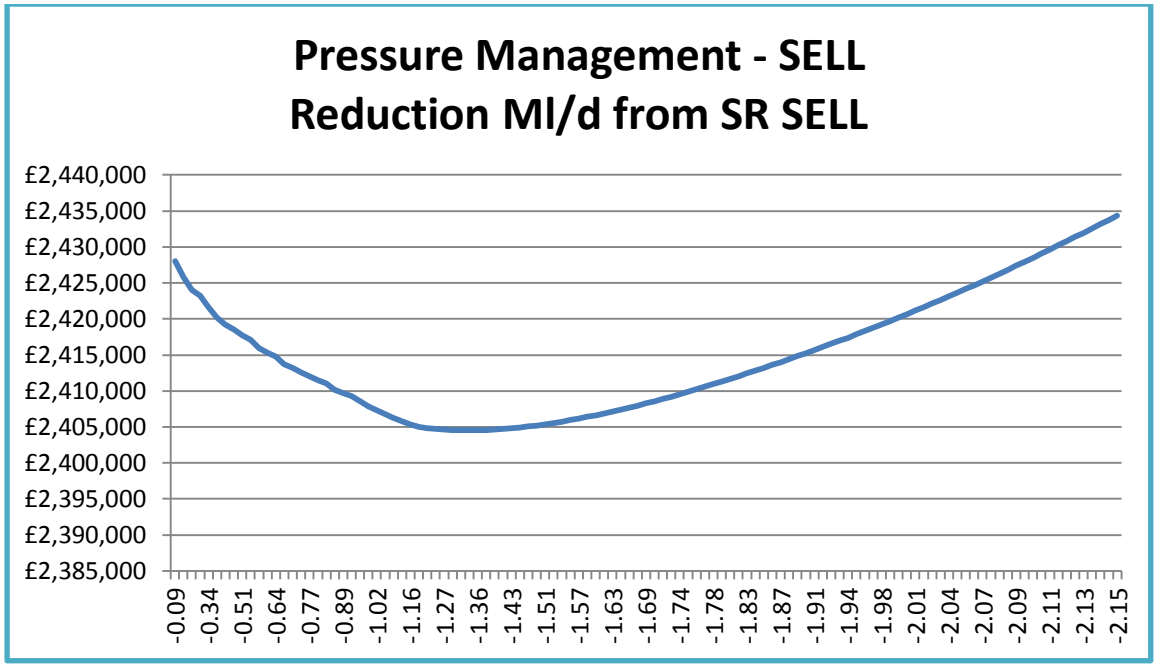
This section only applies to the South Staffs region, where the Company has an extensive data set with robust pre and post data of around 100 pressure management schemes that were carried out from 2004 to 2012. This historic data has been used to develop leakage pressure relationships, that are comparable with other leakage/pressure relationships from external studies and reports and is presented in Figure 33 below.



Leakage pressure relationships

Further to network hydraulic models (Infoworks WS) being developed in the latter part of AMP4 and during the early part of AMP5, data has been extracted for each node. Over 250,000 nodes were analysed, to assist in identifying DMA's with scope for further pressure management schemes. Based on the criteria of having at least 200 nodes (equivalent to around 500 properties) with greater than 30m head pressure, a shortlist of 181 potential schemes was produced. The benefits were assessed in more detail for each scheme, including estimated savings from leakage and bursts. The 40 year benefits and 40 year costs were assessed to compare net NPV. Schemes with a net NPV that was positive have benefits that outweigh the costs and may be economic to implement.

There is considered to be extensive internal experience in assessing costs and benefits associated with pressure management, and a robust data set of data pre and post pressure management that includes changes in pressure, MNF, HDF. Analysis in burst benefits was also updated – with particular focus on periods of the year not susceptible to weather driven bursts to attempt to understand a truer reflection of the longer term benefits associated with pressure management.



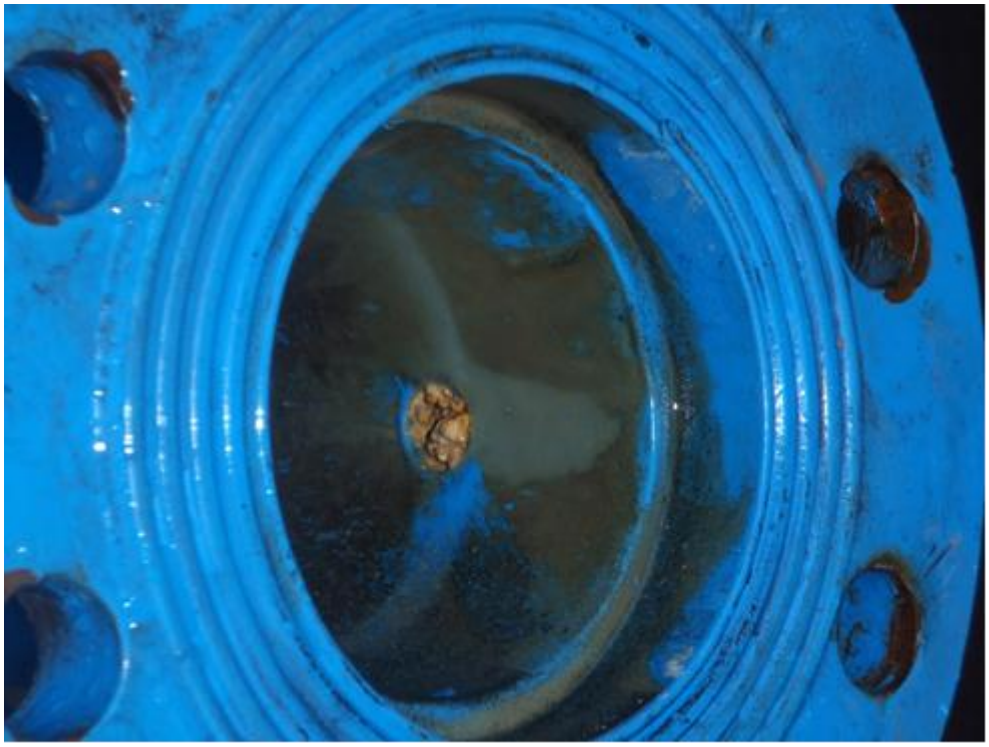
Total 40 year cost of pressure management and MCW relative to SR SELL of 70.54 Ml/d

On this basis in terms of leakage management, it is considered to be economic to deliver 36 new pressure management schemes in AMP6, delivering a benefit of 1.34 Ml/d. This is subject to regulatory and internal approval for expenditure in AMP6. All costs and benefits have been input into the IO tool, which includes customer Willingness to Pay.

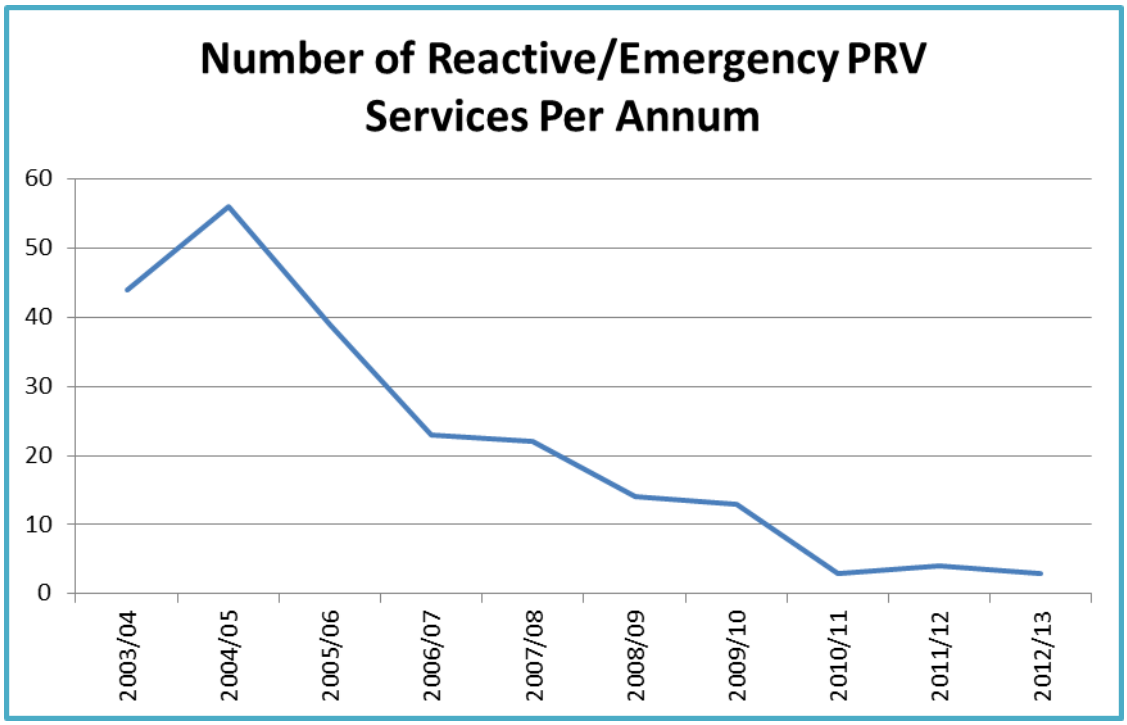
5.6.4 PRV Replacements

SST has 260 operational PRV's and these are maintained on appropriate cycles based on analysis of historic failure data and assessing the condition of valves that are maintained. PRV's can fail resulting in low pressure delivered into the distribution system, or lead to high pressure with the resulting risk of causing leakage and burst mains. Both scenarios can also lead to having a direct impact on the level of service provided to customers.

Historic data is available from 2003 to 2013 covering PRV maintenance and failures. This data has been utilised to derive a relationship in terms of risk of failure in relation to PRV age. PRV's are seen to reach a point where planned maintenance alone is not sufficient to prevent the asset from failing. The example below highlights just one potential issue where internal corrosion has led to a blockage, preventing normal operation of the PRV. In this example there was limited scope to maintain this asset further and it was replaced.

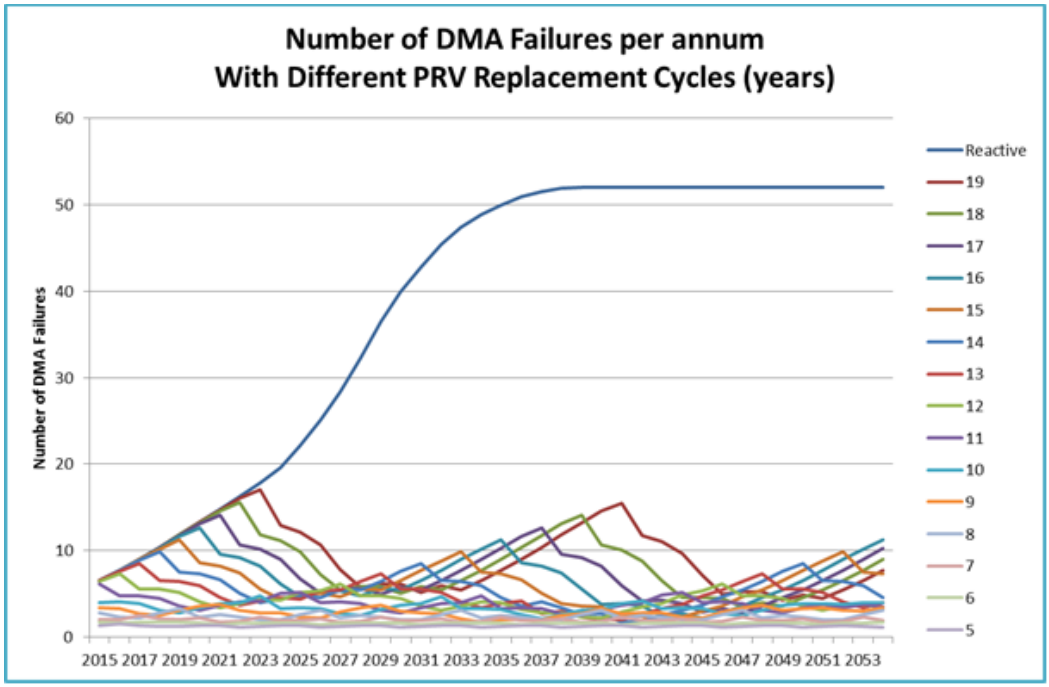


Over the last decade, the installation of new PRV's in conjunction with planned PRV maintenance along with appropriate levels of capital maintenance has seen a significant reduction in the number of reactive and emergency services per annum. This is demonstrated in the chart below.



In the SST region a model uses the relationship between age and risk of failure, along with the current asset information to develop a model that assesses the impact in terms of leakage, interruptions to supply and low pressure based on a reactive scenario (no capital maintenance) along with a series of proactive replacement options. The outputs were exported and run through the Investment Optimisation tool to ensure a level of consistency

throughout the business. The chart below demonstrates the reactive position along with different capital maintenance strategies. The optimum replacement is between 10 and 11 years. The existing asset stock is considered to be near optimal and therefore future investment is primarily related to maintaining the current position.



5.6.5 Data Logger and PRV Controller Replacements

Data loggers and PRV controllers are essential tools linked to the Company's DMA assets for managing leakage. Without on-going capital maintenance investment, the loss of data from these assets would result in deterioration across a number of key areas:

- Reduced efficiency and effectiveness of ALC resources as DMA flow data fails.
- A direct increase in leakage of an estimated 4 Ml/d due to increased pressures as PRV controllers fail and PRV's revert to fixed outlet pressure settings.
- Loss of the ability to proactively monitor the performance of PRV's and control valves and carry out maintenance prior to catastrophic failure.
- The loss of data that is important for general operational management of the distribution network and is also utilised for hydraulic modelling.
- These loggers collect 15 minute average flow and pressure data. There is an AMP5 project underway with Mease/Artesia Consulting to develop a methodology to use fast logging data to improve the current approach to assessing night use, to further improve the current approach and methodology for leakage reporting but also to improve seasonal understanding and provide operational benefits.

The Company purchases data loggers and PRV controllers as a complete package including the devices, batteries, airtime and data hosting/transmission into the business. The cost of removing these to refurbish these assets (battery, seals, airtime as well as site visits to remove and redeploy) is significant and the risk of electronic components and circuits lasting

between 5 and 10 years is considered such that replacement of devices after around 5 years is the preferred strategy. The Company intends to explore whether suppliers would be able to commit to a particular casing longer term, to allow for some efficiencies if these could be recycled or reused.

This investment is also a cornerstone of moving towards a Live Network. In early AMP4 the majority of data was collected manually. Towards the end of AMP4 the development of mobile phone technology led to virtually all of this data being transmitted daily via the mobile phone network. By 2008 the first trials of GPRS data loggers were underway, and by 2010 a strategy was adopted to commence the installation of GPRS loggers as standard. This roll out has been phased across AMP5 with forecast completion by early 2015.

The benefits of near real time data are primarily for improved operational awareness and the ability to either become more proactive in the way that the network is managed operationally, or understand the cause of problems more quickly to support the most effective and efficient responses. There is a benefit to providing this data to a range of users across the business. At present the business is using a web based tool (Qlikview) to provide near real time data from the distribution system to users in the office and field. At present exception reports can be used, but a project is currently underway to assess the scope and potential for more in depth analytics associated with this data, and that captured as part of the focused Live Networks project. The aim rather than generating alarms that require analysis to assess the cause, is to try to identify the likely root cause of a problem and provide business information rather than a series of alarms or exceptions.

5.6.6 Network Metering and Control Valves

This area of investment is associated with large diameter meters installed upstream of DMAs. This investment also includes strategic control valves as there are a number of these that are essential for managing pressures across the trunk mains and some parts of the distribution network, and maintaining a level of flexibility to transfer water around different areas of The Company. This investment includes the following:

- Abstraction Metering
- Distribution Input Metering
- Bulk Export Metering
- Reservoir Metering
- Supply Zone Metering
- Control Valves and Associated Metering

There are two key drivers for this area of investment:

1. Maintaining supply associated with the strategic importance of control valves. Failure of these assets can lead to customer contact in terms of low pressure complaint or interruption to supply. Loss of these critical assets can reduce resilience (e.g. some valves can be used to minimise the risk of customer contact if there are short term trips at pumping stations).

2. Reliable, accurate and robust metering upstream of DMAs is essential to enable leakage upstream of DMAs to be targeted and managed. Currently there is a high degree of uncertainty in the estimation of leakage upstream of DMA’s.

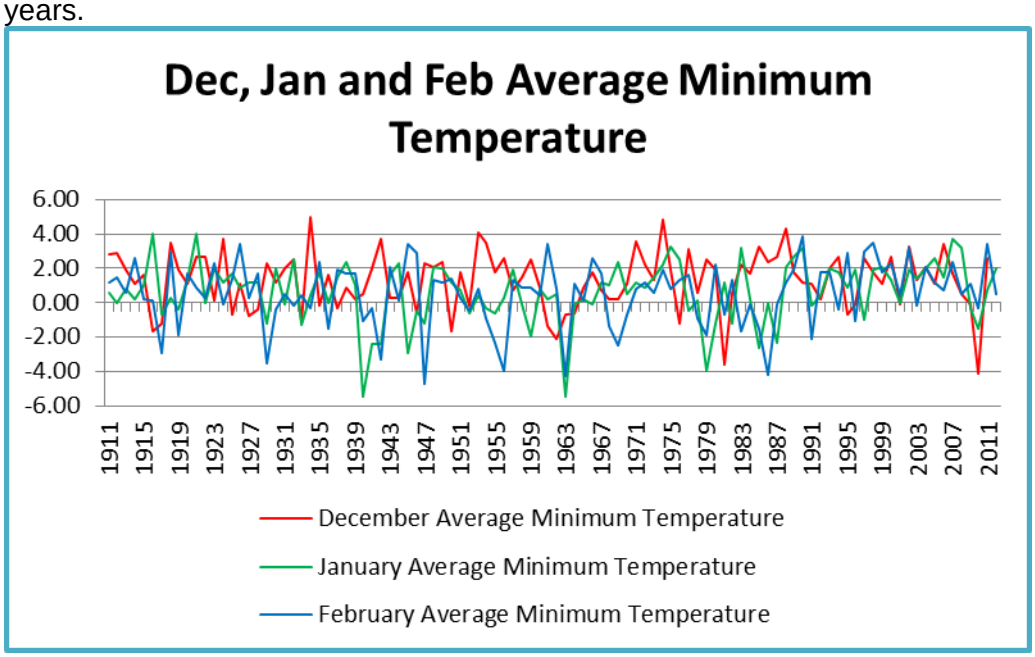
Historic failure data related to strategic control valves has been used to give an indication of the level of risk with age. This has been used in conjunction with hydraulic analysis to assess the potential consequences of valve failure.

In terms of estimating and targeting leakage upstream of DMAs the current metering is not adequate to enable this to be carried out reliably due to a high level of uncertainty. Work carried out by Tynemarch at both PR09 and PR14 supports the need for further improvements in metering, notably on service reservoir inlet/outlets.

5.7 Leakage Target Setting

This section provides additional detail in the approach to proposing AMP6 leakage targets as a range, as set out in the business strategy section related to leakage.

Recent years have seen a significant variation in both summer and winter weather conditions. The winter of 2010/11 was extreme in terms of the impact it had on leakage. Analysis of daily minimum temperature from 100 years of Central England Temperature data gives an indication of the possible return period for a severe winter as being around 1 in 10 years.



The level of leakage is managed between April and November, with the aim of achieving the fixed regulatory target over the financial year, following the winter impact and the operational response to this from the company. In addition to the winter, there is a smaller variation in leakage depending on the summer conditions. 2012/13 as a recent example demonstrated how a very wet summer could have a positive effect in terms of leakage management as there was little breakout of leakage due to saturated soils and reduced ground movement.

The Company has operated relatively consistently in terms of the level of ALC and repair resources during recent years. Therefore the impact of weather on leakage is more straightforward to interpret. To develop the range a number of steps were undertaken:

- Analysis of historic weather data to understand likelihood of occurrence of extreme winter events from operational leakage data from recent years.
- Select winter profiles from recent operational leakage data to represent benign, normal and extreme winter events.

- Derive a normal summer and wet summer leakage profile for April to November.
- Using the normal winter profile as a constant, adjust the normal summer profile for April to November as this is the period the level of leakage is less susceptible to weather, to deliver the normal year SELL.
- The other combinations of summer and winter were used to assess the increase or reduction in leakage that would be observed for different weather combinations affecting both summer and winter.

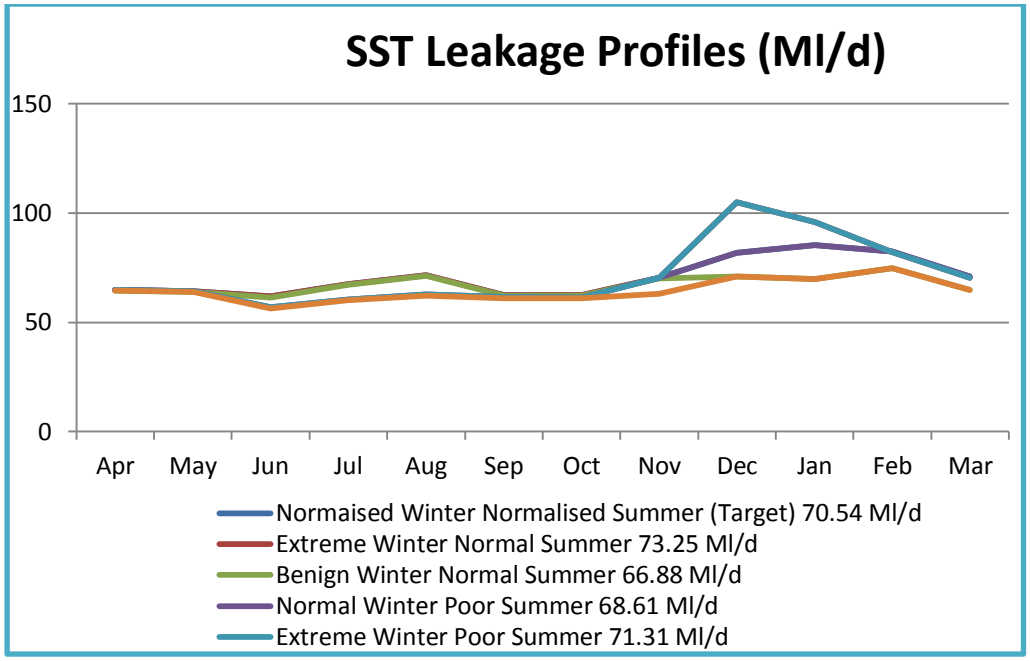
5.7.1 South Staffs Region

The normal year steady state SELL is 70.54 Ml/d. The peak in operational leakage during an extreme winter and associated recovery adds 2.71 Ml/d to the normal year SELL. Therefore a fixed leakage target for AMP6 would be 73.25 Ml/d.

It is proposed that the SELL is set as a range for AMP6, rather than a fixed regulatory target as currently is the case in AMP5. On this basis, SST would expect to achieve 70.54 Ml/d for a normal year position. Using the impact of different weather scenarios on the level of leakage, the upper bound of this range would be 73.25 Ml/d and the lower bound 64.36 Ml/d. These scenarios have been developed using different operational profiles of leakage for summer and winter events, linked to weather observed in recent years, and assessing the likelihood of these events occurring again in the future.

The extreme winter event of 2010/11 forms the basis for an extreme winter scenario. Through analysis of over 100 years of weather data, the return period for a winter event of this magnitude is around 1 in 10 years, although the occurrence of these events is largely irregular.

The lower bound is based on a benign winter which reduces the breakout of leakage through less freeze/thaw events. This is in conjunction with a wet summer, which can also supress leakage. In the context of setting the SELL a range, the benign winter and wet summer could reduce the normal year SELL by 6.2 Ml/d. Recent winters have been relatively benign, 2011/12 and 2012/13 in particular were benign resulting in very good performance in terms of leakage levels.



5.7.2 Cambridge Region

Therefore in the context of a range, 14 Ml/d would form the upper bound of a range.

2012/13 was very wet, with a benign winter, and therefore is indicative of the level of leakage that can be achieved with more favourable weather conditions. Therefore the lower bound of a range would be set at 12.36 Ml/d. As CAM operates below the SELL, it is the aim in this region to manage the level of leakage as close as possible to achieve 14.00 Ml/d. In the event of an extreme winter, resources are expected to be increased to ensure leakage is managed at or below 14.20 Ml/d.

5.8 Proposed AMP6 Leakage Targets (Ml/d)

The Company proposes that leakage targets for AMP6 are set as a range, to take account of the impact extreme weather conditions can have. This will enable lower leakage targets for normal years, while also reflecting the need for the Company to operate in an efficient manner during periods of extreme weather. This will result in improved leakage performance and lower customer bills over the longer term.

The table below sets out the proposed leakage targets (in Ml/d) as a range of upper and lower bounds around the performance commitment for a normal year for both regions.

Scenario	2015/16	2016/17	2017/18	2018/19	2019/20
SST Upper Bound	73.25	73.25	73.25	73.25	73.25
SST Normal Year Performance Commitment	70.54	70.54	70.54	70.54	70.54
SST Lower Bound	64.36	64.36	64.36	64.36	64.36
CAM Upper Bound	14.20	14.20	14.20	14.20	14.20

CAM Normal Year Performance Commitment	14.00	14.00	14.00	14.00	14.00
CAM Lower Bound	12.36	12.36	12.36	12.36	12.36

As identified, the Company's preference is for future leakage targets to be set as a range, with the proposed AMP6 values shown in the table above. If however, it is decided that future regulatory leakage targets are to continue as spot values, the Company would propose the use of the upper bound leakage targets.

5.9 Compliance

The approach taken in both regions is considered robust and compliant with the guidelines set out by the regulators. Both regions have carried out internal analysis, but with external challenge, guidance and review to ensure the approach and methodology taken was fit for purpose.

The Company has assessed both short and long run options as part of the SELL calculations, in line with recommendations from the regulators.

5.10 Key Data Sources

5.10.1 References

- Review of the calculation of the sustainable economic level of leakage and its integration with water resources management planning, (SMC for Defra, EA, Ofwat), 2012
- UKWIR 12/WM/27/6 "Water Resources Planning Tools 2012".
- Met Office website
- UKWIR Managing Leakage, 2011.
- HM Treasury, August 2012, Forecasts for the UK Economy (Table M3)
- UKWIR, 11/WM/80/46 "Best Practice for the Derivation of Cost Curves in Economic Level of Leakage Analysis".
- UKWIR 09/WM/08/39 Large Diameter Trunk Main Failures

5.10.2 External Supporting Projects

Tynemarch PR14 projects for SSW:

- Problematic ALC DMA's
- Leakage Upstream of DMA's
- Estimation of leakage from complex balances

Mease/Artesia:

- Independent Review of SSW Approach to Assessment of Night Use

Beal Consultants (reports)

- Review of South Staffs Water SELL April 2013
- Review of Cambridge Water SELL March 2013
- Review of MCW (SST)
- Review of network deteriorations (SSW)

- Review of long run SELL Oct 2013

5.10.3 Internal Data

- Project Bounty schedule of rates and AMP5 costs
- AMP5 framework agreements (meters, PRV's, data loggers etc.)
- Leakage field system data (job submissions etc.)
- LMARS
- Water XP
- Rapid
- Strumap
- Inforworks Hydraulic Models
- Data used for internal reporting (e.g. leakage, repairs, ALC performance)
- Independent meter testing data (EM meter specification, insertion probes, EM meters, DMA meter testing etc.)
- Surveys of network metering and control valve sites (MWH)
- Historic failure data (PRV's, control valves)
- University of Birmingham project – customer contact linked to network events
- Trials – live network (long range radio etc.)
- Pre and post examples (network metering/control valve site improvements)
- PRV Maintenance records
- PRV condition assessments
- Navison (CAM)
- WaterWorks (CAM)
- Report H005 – ALC data (CAM)
- Report D007 – Marginal Cost of Water (CAM)

The above is not exhaustive but is intended to illustrate there is a solid data set of internal data and analysis, supported by external support and peer review where appropriate and utilisation of external documentation where relevant.

There are too numerous individual calculations, models, and individual sources of data to list without an extensive document. The following is a summary of the OPM's utilised by the aforementioned leakage management driven schemes.

6. Conclusion

Managing the serviceability of the network is an on-going challenge requiring investment across many asset groups, applied in accordance with good asset management practices. The Company is confident that the investment arguments made within this document have been developed by expert asset managers, using robust data sources and sound analytics to develop solutions that will ensure the network remains able to deliver the serviceability that the Company requires and that our Customers expect and value.

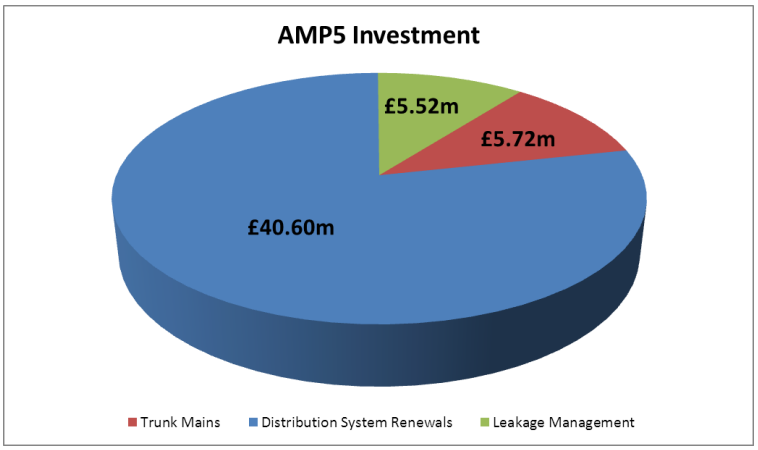
The Company has proposed some innovative projects (for example; the 'live' network); some new initiatives (such as trunk main monitoring) and then a number of projects that are similar to, or a continuation of, work undertaken during recent AMP periods. The 'optioneering' approach adopted for the development of this business plan has ensured that all of these proposals, whether new or continued, have been developed from the bottom-up. This approach guarantees that all of the proposals are based on genuine 'needs', with robust business cases.

6.1 Summary of historical investment and proposed future investment

The strategy for maintaining the network into AMP6 requires a slightly higher level of investment than previous AMPs. The following sections describe the key differences:

6.1.1 Historical Investment

Investment on network assets during AMP5 has predominantly focused on small diameter mains renewal, for both the South Staffs and Cambridge regions. The chart shows the high level breakdown of this investment, with asset renewal accounting for just over £40m, 78.3% of the total network investment. Trunk Mains is the next largest investment area at 11%, with Leakage Management investment at 10.7%



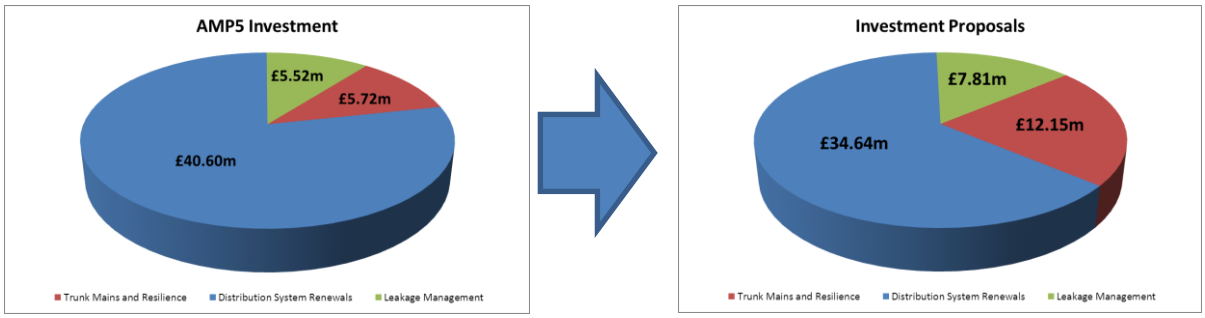
For the South Staffs region, 24.5% of the overall investment programme is being spent on renewal activity, this high level of work is representative of the serviceability improvements that the Company has been delivering; within the Cambridge region, the investment level is 21.3%, maintaining the stable service position already achieved.

The 'Trunk Mains and Resilience' spending is focused on Network Reinforcement in both regions, supplemented by large diameter PVC renewal in the South Staffs region.

Leakage management funding is split into three main groups, with DMA maintenance using 54% of this funding, followed by network metering and control valve maintenance at 32% and new DMA installations at 14%. This division reflects the fact that both regions now have established DMA infrastructure, and most of the leakage management funding is now required for maintenance of existing assets.

6.1.2 Optimised AMP6 Proposals

As discussed throughout this strategy document, the Company is refocusing some investment for AMP6, to address service risks related to trunk main assets. The comparison below shows the proportional changes from AMP5 to AMP6:



The above charts are not only demonstrative of a significant change in strategy, but also reflect the fact that the Company has used optimisation to divide the funding; focusing spending on asset maintenance and high impact trunk main assets, where benefits are significant.

Small diameter renewal activity still commands the primary share of the proposed network investment, but this is 15% lower than AMP5, at £34.49m. The total length of the Company's networks is now over 8,300km, some of which is already over 100 years old. Renewal activity is therefore still a large proportion of the proposed investment, and will continue to be so for future investment periods; however, as evidenced earlier in this document, the Company has undertaken very robust analysis to ensure that an optimal amount of funding is proposed, which is then targeted as effectively as possible to ensure best value for customers.

Investment in the 'Trunk Mains and Resilience' group is increasing for AMP6. This is principally due to the increased spending proposed for trunk main maintenance, network resilience improvements, large diameter ferrous and PVC renewals and live monitoring of high risk mains.

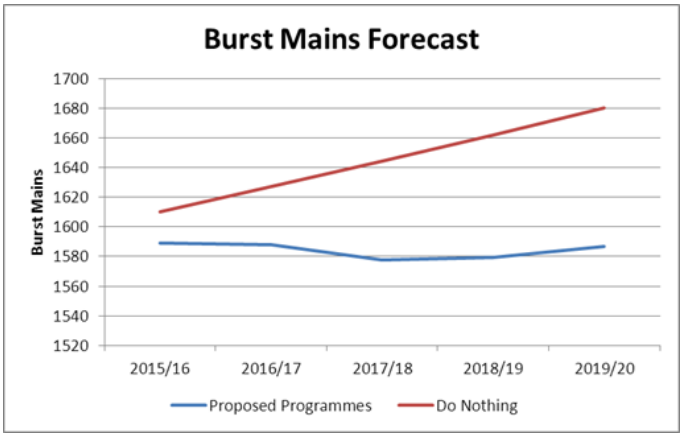
Summarised AMP6 projects:

Scheme	AMP6 Investment	AMP5 Comparison
Trunk Main Condition Assessment	£300k	- £13k
Trunk Main Maintenance	£3.73m	+ £3.12m
Network Reinforcement	£2.12m	+ £118k
Network Resilience	£881.2k	+ £881.2k
Large PVC Renewals	£3.38m	+ £630k
Large Diameter Renewals	£982.8k	+ £982.8k
Trunk Main Monitoring	£750k	+ £710k
Small Diameter Condition Assessment	£148k	- £21k
Small Diameter Renewals	£34.49m	- £5.94m
New DMAs / Pressure Management	£1.28m	+ £498k
DMA Maintenance	£2.74m	- £243k
Network Metering / Control Valves	£2.89m	+ £1.14m
Live Network	£897k	+ £897k
	£54.59m	**+ £2.76m (5.3%)**

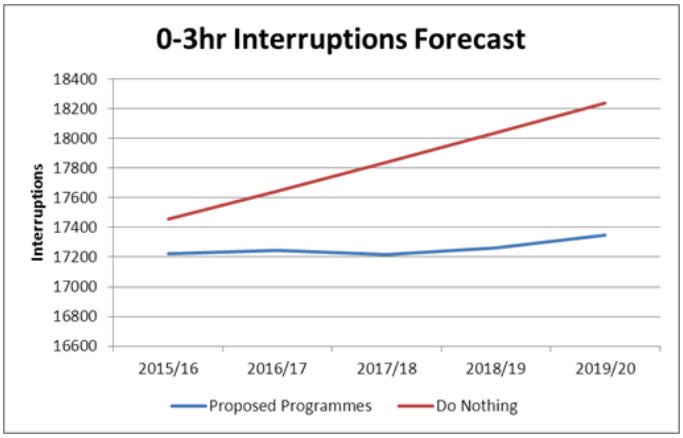
6.2 Forecast changes in performance measures

The effectiveness of the above investment strategies for network assets has been assessed by using the outputs from the IO tool.

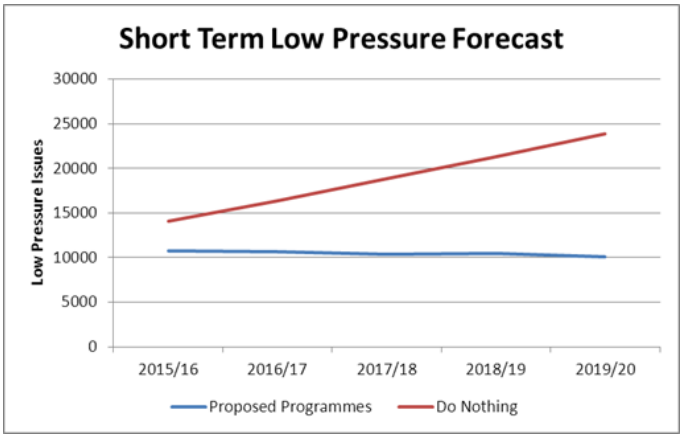
The benefits associated with each project are entered into the IO tool workbooks to allow the costs of each project to be assessed against the expected benefits delivered. When all of the selected workbooks are combined into an optimised portfolio, it is possible to 'roll up' the benefits from all of the constituent workbooks to determine the overall benefits delivered to customers.



The final investment portfolio has been assessed for some of the service indicators that are typically associated with network assets. The resulting graphs show the impacts of the investment against modelled 'do nothing scenarios', with the expected positions shown as blue lines, alongside the 'do nothing' forecasts shown in red. The difference between these two lines is the benefit delivered by the investment.



As set out in the introduction to this strategy, the Company's aim is the continued delivery of stable serviceability to our Customers. The graphs shown here illustrate the forecast changes to some of the key performance indicators; revealing that serviceability is expected to remain stable with the implementation of the proposed projects. This forecast outcome is ratified and supported by internal stakeholders and asset managers.



South Staffs Water

incorporating

CAMBRIDGE WATER COMPANY

Maintaining the Water Quality Compliance and Serviceability of Non-Infrastructure Assets

Investment Strategy

December 2013

Executive Summary

The capital investment that the Company has undertaken in AMP5 has ensured that the assets have maintained stable serviceability and provided the foundation for this to continue in the future with continued investment. The future investment strategy for non-infrastructure assets has been developed from a strong risk based approach, based on customer expectations and values and with a focus on affordability in the context of long term performance and stability of service.

The headline contents of this strategy are:

Continuing with the borehole maintenance programme started in AMP5

At PR09 the Company made a strong business case for increased investment in its borehole assets due to an aging asset base and strong indicators of deterioration. This programme is on track within AMP5 and will continue into AMP6 and beyond.

Dealing with rising groundwater nitrate levels

The Company has rising groundwater nitrate levels in both of its regions and solutions need to be put in place to blend or treat these nitrates for continued water quality compliance. Support has been gained from the DWI for two schemes and the Company will also work with farmers in its region to reduce fertiliser use over the long term.

Continuing with treatment gas independence in the CAM region

A programme of work started in AMP5 is on track and will be continued into AMP6 as planned. Current reliance on gaseous disinfection will be completely removed leading to increased resilience of the assets.

Maintaining high energy efficiency and utilisation of renewable energy

The Company has invested in its energy efficiency activity over the past ten years and this investment has a huge impact on power use and therefore operating costs and operating efficiency. This industry leading activity will continue into AMP6 along with installation of solar photovoltaic assets, where economic, which will be used to displace existing grid electricity consumption.

An increased programme of service reservoir maintenance to address deterioration

Detailed engineering based surveys utilising recognised industry expertise have identified the need to undertake a rebuild of one service reservoir in AMP6 followed by one in AMP7. These assets are aging and continued investment will be required in the future to ensure that these critical assets continue to meet expected standards of service.

Continued maintenance of pumping and treatment assets

The Company will need to continue to invest base capital maintenance in its assets overall to ensure that deterioration is controlled and that asset serviceability is maintained. The Company's risk based approach to risk identification ensures that capital investment is targeted effectively, and this approach helps maintain the Company's position as one of the lowest capital spend Company's (relative to population) in the industry.

This will deliver benefits to all five of the Company's outcomes:

	**Excellent water quality (now and in the future)** Non-infrastructure assets are strictly controlled by drinking water standards. A large number of water quality parameters are either measured or treated as part of the water abstraction processes which take water out of the ground and from rivers and deliver it into the supply system. It is essential that the Company maintains its assets in a state which will ensure full compliance with quality standards.
	**Secure and reliable supplies (now and in the future)** It is the non-infrastructure assets that provide the clean high quality drinking water into the supply network for delivery to customers. It is essential that the Company maintains its water production assets to be reliable and able to meet the demands placed on them during peak demand periods and in extreme circumstances, such as drought.
	**An excellent customer experience to customers and the community** Although the non-infrastructure assets themselves are quite far removed from customers in terms of direct visibility of operations, they nevertheless have a huge impact on customer service measures. The appearance, taste and smell, pressure and supply reliability of water to the customers taps can all be affected by the non-infrastructure asset base and below par performance in any of these attributes would influence the customer service performance of the Company.
	**Operations which are environmentally sustainable** The Company's assets interact with the local environments in various ways. This could be the effect of groundwater abstraction on local watercourses or the effects of treatment effluent discharges. The Company takes its environmental responsibilities very seriously and assets must be maintained to ensure compliance with any relevant statutory duties.
	**Fair customer bills and fair investor returns** Operation of the non-infrastructure assets to abstract, treat and pump water to customers' homes and businesses costs money. The cost of energy and chemicals is rising and a significant labour force is needed to operate and maintain its assets. The Company is continually reviewing how it can drive costs down and in particular power, where rising costs are having significant effects on customer bills at each price review.

The table below shows the expenditure in line with the themes used within this document, and compares the AMP5 forecast and AMP6 planned expenditure for the combined SSC water undertaker.

Theme	SSC AMP5	SSC AMP6	+/-
Maintaining groundwater pumping station reliability and quality compliance, borehole maintenance programme	£2m	£2.8m	+£0.8m
Maintaining groundwater pumping station reliability and quality compliance, civil refurbishments	£0.8m	£0.8m	£0
Maintaining groundwater pumping station reliability and quality compliance, mechanical and electrical refurbishment	£7.3m	£7.3m	£0
Dealing with nitrates at groundwater pumping stations	£7.6m	£9.1m	+£1.5m
Treatment gas independence (TGI) in the CAM region	£2.2m	£3m	+£0.8m
Maintaining surface water storage reservoirs	£0.1m	£0.5m	+£0.4m
Maintaining water treatment works reliability and quality compliance, civil refurbishments	£1.8m	£1.5m	-£0.3m
Maintaining water treatment works reliability and quality compliance, mechanical and electrical refurbishment	£7m	£6.1m	-£0.9m
Maintaining energy efficiency of pumping stations and installation of renewable energy plants	£2m	£3.1m	+£1.1m
Maintaining structural integrity and quality compliance of service reservoirs	£2.5m	£7.5m	+£5m
Maintaining booster pumping station reliability, mechanical and electrical refurbishment	£3m	£1.7m	-£1.3m
Total	**£36.3m**	**£43.4m**	**+£7.1m**

The non-infrastructure assets as a whole require an uplift in capital maintenance expenditure of £7.1 million. This includes the quality compliance schemes for which the Company has gained DWI support. In total, the DWI have supported and intend to issue notices for approximately £2.3 million for the Company's plans for dealing with rising groundwater nitrates. An additional £1.8 million for the treatment gas independence programme in the CAM region is driven by resilience needs under the Security and Emergency Measures Direction and is therefore also necessary. These obligations summate to £4.1 million of the £7.1 million increase.

The Company has traded off expenditure requirements within the non-infrastructure assets to partially fund assets which require uplifts in expenditure. This has been done with full consideration and detailed analysis of the individual assets involved and the risks they present over the next 25 year period.

Of the £43.4 million for Maintaining the Water Quality Compliance and Serviceability of Non-Infrastructure Assets, 81% is cost beneficial, excluding regulatory driven schemes and projects continuing from AMP5.

Contents

1. Introduction

This document details the business strategy for the continued and effective maintenance of the Company's non-infrastructure assets related to water production, storage and transfer. Within South Staffs Water, these assets are collectively known as the *'Production'* assets, with the large diameter trunk mains and smaller diameter distribution mains network being known as the *'Distribution'* assets. The Distribution assets are covered in the Maintaining the Serviceability of Network Assets Investment Strategy document. The Production assets consist of the following high level asset groups:

- **Groundwater pumping stations** where boreholes abstract water from underground aquifers, treat it, and re-pump it into the distribution network;
- **Surface water storage reservoirs** which store large volumes of raw water from rivers prior to treatment;
- **Surface water treatment works** which treat raw surface water stored in surface water storage reservoirs and then pump it into the distribution network;
- **Service reservoirs and water towers** which provide potable water storage within the distribution network; and
- **Booster pumping stations** which provide re-pumping of potable water within the distribution network.

All of these assets operate within the context of the distribution network and are integrated completely with it, operating as a self-contained system of supply and demand.

South Staffs Water has two independently operating resource zones, the SST region predominantly in the West Midlands and Staffordshire, and the CAM region centred around the City of Cambridge. These two resource zones are not interconnected in any way. The SST region is bordered entirely by Severn Trent Water, and the CAM region is bordered by Anglian Water to the north, east and west and Affinity Water to the south.

2. Supplying Customers with Wholesome Clean Water

The Company has an obligation to supply clean, wholesome water directly to its customers' homes and businesses, in accordance with the Water Industry Acts 1991, 1999 and 2003.

The assets which the Company operates and maintains make this possible.

Customers in South Staffs Water's SST and CAM regions receive drinking water of very high quality with very low levels of interruptions to service. This is what customers want, and what they pay for. South Staffs Water achieves this with bills which are amongst the lowest in the industry, achieved through efficient capital maintenance and efficient operating expenditure.

Customer engagement that the Company has undertaken in the past, and recently for the PR14 business plan, has consistently shown that customers value the quality and reliable supply of water above all else. This is the core of the Company's existence and therefore has rightly been the focus of the Company's strategy in the past and will continue to be the focus in the future. The assets the Company owns must continue to operate reliably and be in a condition which does not put the high water quality standards at risk. This is the service level which the Company operates at and this is the service level it will maintain in the future.

The Company must operate its assets in other contexts too.

Consideration of the natural environment is an important area which customers also value highly and the assets operated by the Company must deliver a level of performance and acceptable level of risk to the natural environment. There are ever increasing pressures to reduce abstraction to protect vulnerable aquifers which can sometimes be in conflict with the way that the Production assets are operated to manage quality and operating costs on a day to day basis. Where the Company operates treatment plants there must be consideration of safe disposal of effluents and sludge to ensure the natural environment is not adversely effected or put at risk. For more information on the Company's environmental activities please refer to the Protecting the Environment Business Strategy.

Energy efficiency is another significant consideration. Energy costs have risen dramatically over the last 10 years and the Company's annual energy bill is now over £8.6 million and forecasted to rise to £10.6 million by 2020. This puts increasing cost pressures on customer bills at price reviews. The Company works hard to mitigate the effects of energy price increases by ensuring its assets are as efficient as they can be. An industry leading pump efficiency programme detects and intervenes when pump performance is less than economically acceptable; and the configuration of the distribution network is under constant review for opportunities to reduce energy use where it is cost effective to do so. The Company has looked closely at renewable energy sources, some of which are cost beneficial to implement. More information on this activity can be found in Section 7: Energy Efficiency Programme and Utilisation of Renewable Energy

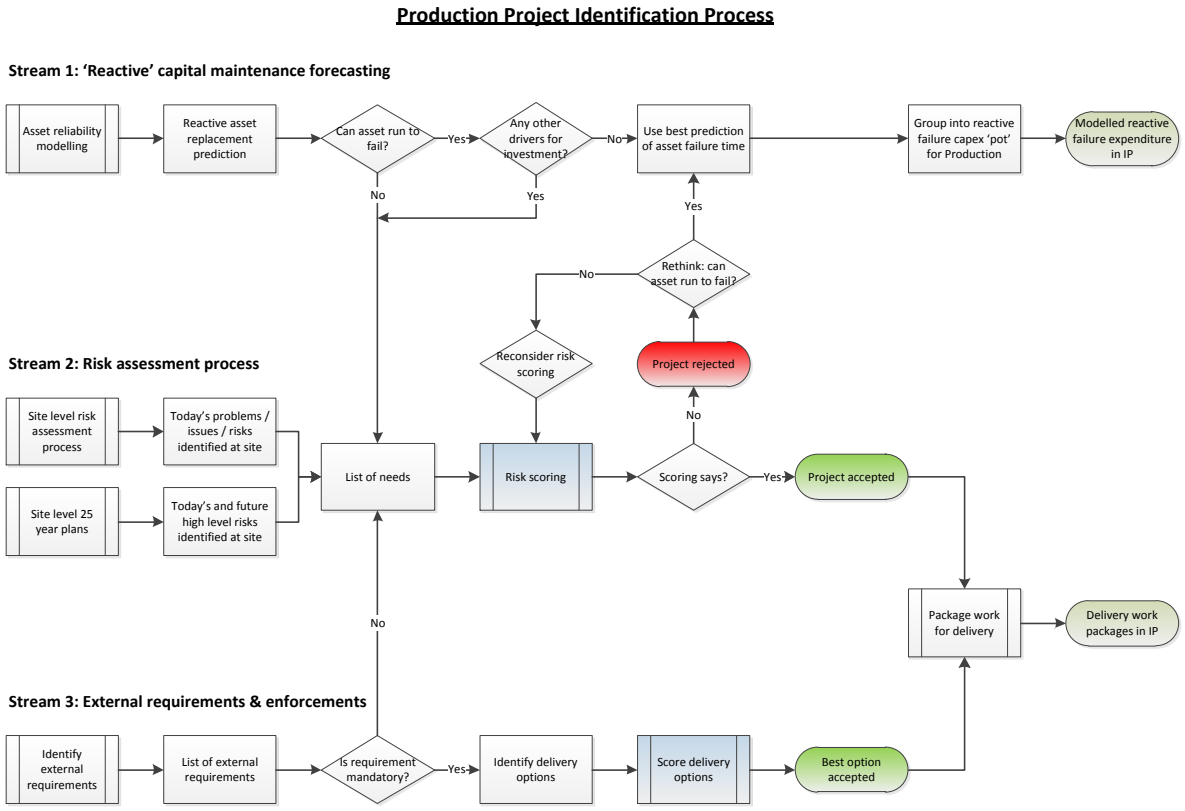
As well as these external factors, the Company also has an obligation to its own employee safety. A strong health and safety culture exists within South Staffs Water and assets and working practices are under continual review to ensure that any risks are managed appropriately.

3. The Asset Management Approach

The Company has followed a risk based asset management approach aligned with PAS-55, encompassing the Common Framework and the principles of Ofwat's previous AMA process.

Overall, the Company has utilised a combination of bottom up risk assessments, top down twenty five year planning and deterioration modelling to determine the investment needs for these assets. In house expertise has been supplemented with external consultant support where necessary. The processes followed to determine these investment needs, whilst inevitably geared around the five year regulatory cycle, are nevertheless business as usual. Governance processes which already exist for capital maintenance expenditure within the planning period have been applied to the AMP6 proposals to ensure that the proposals are affordable, fit with the Company's overall strategy, are aligned with customer views and are deliverable from an engineering point of view within the timeframe.

The overall process used for the non-infrastructure 'water production' assets is as follows:



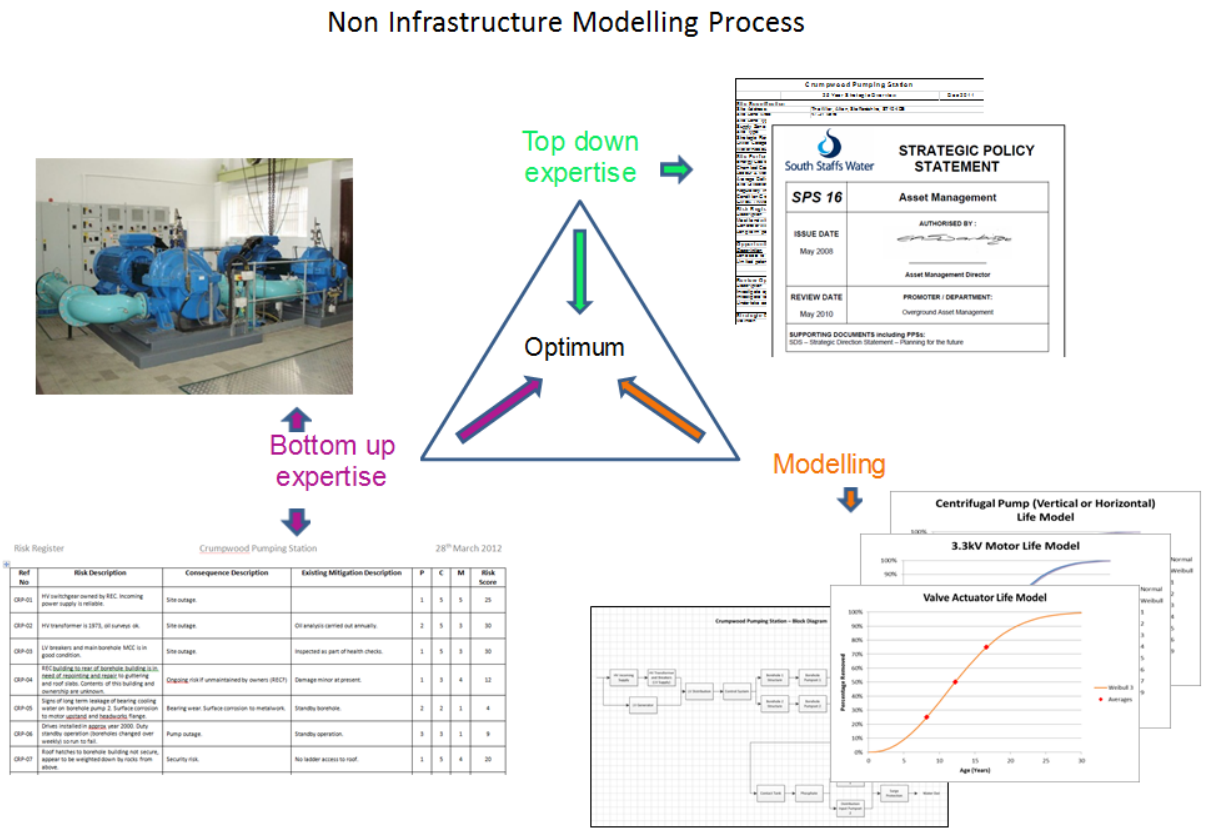
This process brings together the best practice elements of deterioration modelling, detailed site assessments and asset surveys, top down 25 year planning, external regulatory drivers and it tracks all these needs through a risk scoring methodology, the *Investment Optimisation* (IO) process. This risk scoring methodology determines the value of the risk and how it affects service to customers.

The Investment Optimisation process is the framework by which the Company has scored all of its risks and investment proposals. The framework consists of a number of *Output Performance Measures* (OPM's) which allow the scoring of various elements of service

provision, including (but not limited to) supply interruptions, water pressure, water quality, health and safety and energy use.

Every identified risk has been scored using the framework and incorporated into a full portfolio analysis along with the risks and needs from other areas of the business. The IO process includes a risk valuation framework, derived from customers' willingness to pay surveys, internal unit costs and socio-environmental values. This risk valuation framework is applied to the scored risks, from which a net present value is calculated. The IO software is then able to optimise the portfolio based on cost and performance constraints set by the Company, to determine the most cost beneficial portfolio. This analysis has been undertaken across multiple iterations using a range of cost constraints, performance constraints and uncertainty analysis to ensure that the proposed capital maintenance plan is able to optimally deliver the service required within the affordability constraints set by the business.

To support the bottom up risk assessment process and IO process, a set of deterioration models were developed. This follows on from the Company's development of two non-infrastructure deterioration models at PR09 and expands the set of models to a total of fifteen models covering a wide range of equipment types common in the Company's asset base. Both life models and repair rate models have been developed to account for both capital and operational activity. This graphic shows how all of these processes fit together.

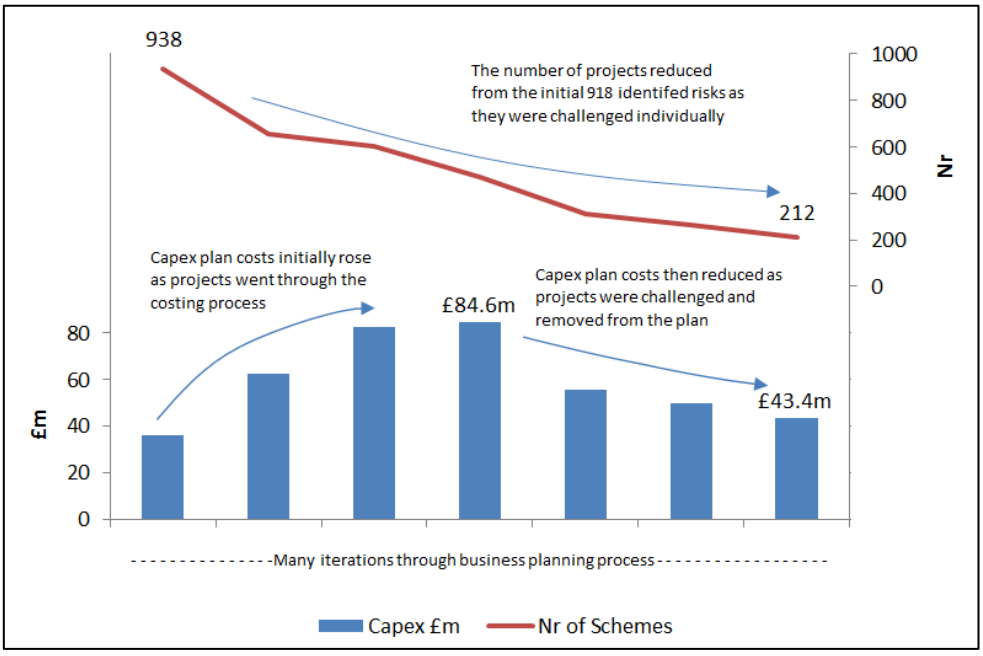


The overall process includes a substantial degree of internal and external challenge. External challenge has been undertaken by the Customer Challenge Group (CCG) utilising Monson for engineering expertise. Further detail on this can be found in Section 8: Engagement and Challenge with the CCG.

Internally, the challenge has consisted of several concurrent processes including:

- Validation of the risks identified from the bottom up and top down processes by internal engineers, departmental managers and directors;
- Validation of the assumptions used in scoring those risks within the IO framework, again by internal engineers, departmental managers and directors;
- Consultant support for the large projects such as the reservoir rebuilds and the nitrate plant refurbishments to ensure the engineering judgements and cost estimates are robust; and
- Validation of the portfolio optimisation scenarios (separately for both the SST and CAM regions), to ensure that the capital maintenance proposals deliver the required level of service at an acceptable level of risk and within the affordability constraints set by the business.

There have been multiple iterations of all of the above challenge activities resulting in a significant reduction from earlier predictions of capital maintenance funding. This iterative approach has been used at previous price reviews and really drives down the capital maintenance plan ensuring that only essential interventions are put forward:



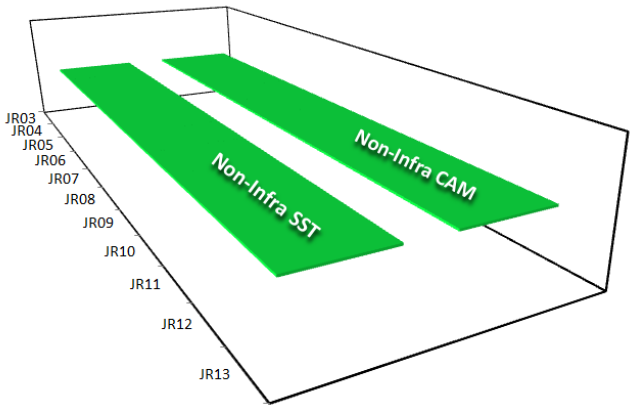
The Company has utilised consultant support from Mott MacDonald for its overall asset management activity and development of deterioration models; and from SGS UK Ltd to provide guidance for the Company's PAS-55 implementation which is ongoing. Both consultants have been utilised to provide guidance and support for the asset management activities carried out internally, not to provide asset management outsourcing. The Company is 'close to its assets' at all levels within the business and believes that this high level of internal ownership is key to achieving robust levels of service today and in the future whilst retaining the ability to be flexible and efficient for continued low bills compared to the rest of the industry.

Further information on the high level asset management approach is documented in the Asset Management business strategy.

4. Non-Infrastructure Serviceability

Serviceability is a measure of how well the assets can deliver their expected service now and in the future. It is a measure that has been in place within the regulatory environment since the 1990's, and has developed to include the serviceability indicators which the Company uses today. The serviceability assessment approach used by the Company is the same as Ofwat's approach before the process of assessment was handed over to companies in 2010. It is predominantly a trend approach, where each indicator is examined for general positive or negative trend each year. Each indicator has a reference level and control limits designed to guide the analysis of trend and to provide boundaries to the four assessment bands of Improving, Stable, Marginal or Deteriorating.

Since 2003, the Company has maintained stable non-infrastructure serviceability in both regions:



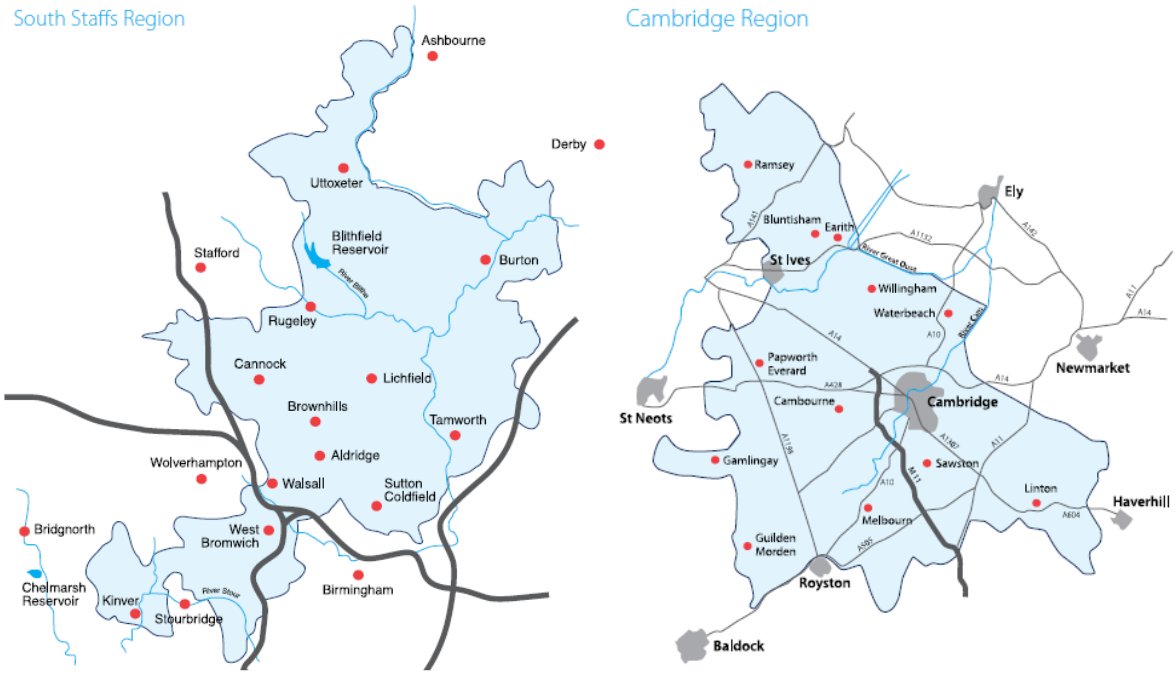
The serviceability indicators which the Company will use internally in the AMP6 period remain unchanged from its AMP5 indicators. Reference levels and control limits remain unchanged from those set as part of the PR09 price review. They are:

Indicator	Reference Level SST	Control Limits SST	Reference Level CAM	Control Limits CAM
Water treatment works coliforms	0.03%	Lower = 0% Upper = 0.1%	0.13%	Lower = 0% Upper = 0.28%
Service reservoir coliforms	0%	Lower = 0% Upper = 5%	0%	Lower = 0% Upper = 3.33%
Water treatment works turbidity	0 nr	Lower = 0 nr Upper = 1 nr	0 nr	Lower = 0 nr Upper = 3 nr
DWI enforcement actions	0 nr	Lower = 0 nr Upper = 1 nr	0 nr	Lower = 0 nr Upper = 1 nr
Unplanned maintenance	3431 nr	Lower = 2596 nr Upper = 4266 nr	588 nr	Lower = 470 nr Upper = 706 nr

The Company will continue to maintain its assets to ensure that they are fit for purpose to serve today's customers and future generations of customers. This capital maintenance plan for non-infrastructure assets will deliver stable serviceability for AMP6 and provide the foundation for stable serviceability into the future for AMP7 and beyond.

5. The Regions

The South Staffordshire group recently acquired Cambridge Water and was granted permission to combine it with its existing water company South Staffordshire Water, with both businesses now operating under a single license. There are two resource zones as shown below. The two regions are not connected.



Attribute	SST Region	CAM Region
Size	1,500 km^2	1,170 km^2
Population	1,200,000	313,000
Number of household customers	535,000	120,000
Number of commercial customers	34,000	10,000
Average daily demand	331 Ml/d	76 Ml/d
Bordered by	Severn Trent	Anglian & Affinity

Both the SST and the CAM regions operate as single resource zones with high interconnectivity. This network arrangement, developed over more than a century of investment and growth, benefits customers for a number of reasons:

1. **Maintain quality through blending solutions** for nitrates. Many of the groundwater sources suffer with elevated nitrate levels. The integrated network provides opportunities to blend these sources with each other to attain compliance, which avoids the need to construct expensive treatment plants at every groundwater source.

2. **Day to day supply resilience for customers** as this integrated network and strategic storage capacity provides for inbuilt resilience against unplanned events within the network, for example upstream trunk mains bursts or unplanned outages of supply sources.

3. **Flexibility to maintain the assets** as when reservoirs, treatment works or groundwater assets need to be taken out of supply for maintenance the integrated network and strategic storage capacity allows this to occur without any impact on customer supplies.

4. **Flexibility to operate the assets efficiently** as the ability to transfer bulk volumes of water around the region allows the Company to optimise its pumping regimes to extract value from variable energy tariffs and differences in treatment costs between the sources. This helps keep operating costs low.

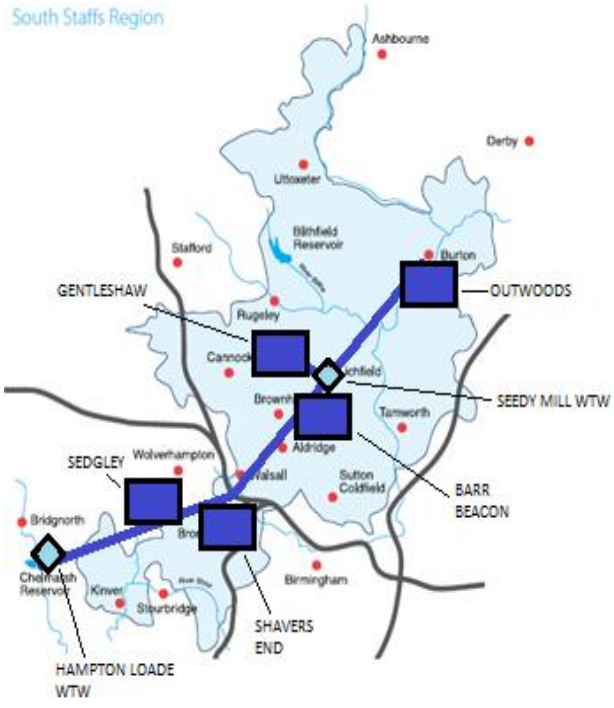
5.1 The SST Region

The SST region operates with a highly interconnected distribution network, the infrastructure for which was predominantly built from the late 1800's through to the 1960's. This infrastructure was developed around the area known as the 'Black Country' which encompasses the major towns of Dudley, Tipton, West Bromwich, Oldbury and Walsall. Infrastructure was initially designed to bring water south from the Lichfield area into the Black Country, although around the turn of the twentieth century additional groundwater sources were constructed in the south which were much closer to the demand areas.

Sources were also developed north of the Black Country to supply growing towns such as Lichfield and Cannock, and then later, Uttoxeter and Burton upon Trent. During the early to middle twentieth century some local water authorities were integrated into South Staffs Water, particularly in areas such as Uttoxeter and Tamworth. South Staffs Water inherited the assets supplying these areas but also added additional infrastructure to integrate these discrete areas with its own existing network.

Essentially, the SST region centres its operation around a trunk mains and service reservoir system which runs through the centre of the region, acting like a spine. The bulk of water production is in the south west of the SST region, from the Hampton Loade Water Treatment Works on the River Severn and from the Smestow Valley groundwater sources; and is transferred north east along this spine of storage reservoirs and trunk mains. There is also a significant volume of water produced in the central area of the SST region from the Seedy Mill Water Treatment Works which is supplied from an impounding reservoir at Blithfield, and there are also a number of groundwater sources located centrally.

To the north of the region there is a small volume of groundwater production supported by bulk transfers from south to north through the distribution network.



This diagram shows a simplified view of the trunk main spine running from south west to north east and the location of the two surface water treatment works at Hampton Loade and Seedy Mill.

The five strategic reservoir sites are also shown.

The two treatment works alone provide 60% of the daily supply volume, and the five strategic storage reservoir sites provide over 70% of the total storage capacity for the region.

The majority of the groundwater sources feed into this trunk main system either in the south west or around the central area, with a small number of groundwater sources located in remote areas in the north and north east.

The SST region is very hilly, and as a result SST has the highest average pumping head in the industry. Some of the large service reservoir sites are not ideally located to maximise

energy efficiency. Between 2009 and 2011 the Company embarked on an internal project, named *Aquarius*, to undertake comprehensive investigations into how the trunk mains network is configured to determine if it was economically viable to undertake significant redesign to achieve reductions in energy use and carbon emissions. Amongst the options considered was the relocation of large storage reservoirs to lower elevations, in order to reduce the pumping costs and carbon emissions associated with pumping to high elevations. Extensive investigations and modelling proved the options to be too costly to implement primarily due to the very high capital cost associated with relocating service reservoirs and trunk mains. The trunk mains network currently in place has developed and grown through more than a century of investment, and it is unlikely that large scale projects such as these will ever become cost beneficial. Even with a cost beneficial business case, the impact on customer bills in the short term would have been significant to fund the capital investment necessary to implement the changes. This would have been difficult to justify to customers in any economic climate, let alone the current one of austerity.

It is for this reason that the company policy is to maintain the existing network configuration indefinitely, which means the Company must be committed to maintenance of the individual assets making up this network configuration over the long term. This allows the Company to plan proactively, holistically and most importantly cost effectively for the future of these assets operating within the network. Smaller network reconfiguration options will continue to be explored where these are cost beneficial and do not adversely impact on customer bills.

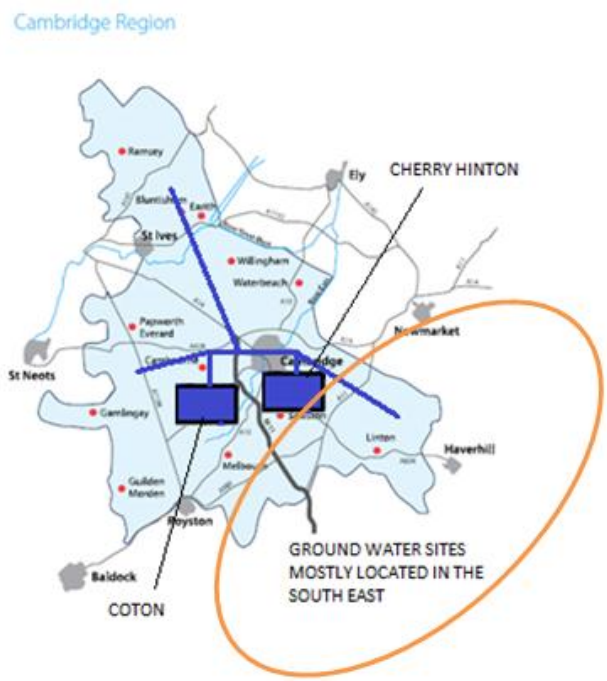
5.2 The CAM Region

The CAM region also operates with a highly integrated network.

All of the water in the CAM region is supplied by groundwater pumping stations predominantly in chalk aquifers. The vast majority of these sources are located in the south and south east of the region with exception of a large source situated 54 km away to the north east in the Anglian Water area in the Thetford forest.

The groundwater sources predominantly pump directly into supply and are supplemented at daily peaks by a large reservoir system (four independent interconnected structures with a capacity of 59 Ml) at Cherry Hinton which fills at times of low demand from the groundwater sources.

Water migrates from the groundwater sources and the Cherry Hinton reservoirs across Cambridge via the trunk main network to a storage site at Coton, it is then transferred to further storage sites in the north and west of our area to supply the demand in those regions.



This diagram shows a simplified view of the distribution system in the CAM region.

The majority of groundwater sources are in the South East of the region. All sources pump water directly into the distribution network. Large storage reservoirs located at Cherry Hinton, Coton and other sites provide the strategic storage needed to support peak demands. Cherry Hinton is the largest reservoir site in the CAM region with a total of 59 Ml capacity provided by four independent structures.

Water then moves north and west using smaller storage reservoirs and towers to support the extremities of the region.

6. The Assets

The Company operates the following assets related to water production, storage and transfer within its distribution networks in the SST region and the CAM region:

Asset Type	Function	SST Region	CAM Region
Groundwater pumping stations	Abstraction of groundwater	24	28
Surface water reservoirs	Storage of raw surface water	2	0
Surface water treatment works	Treatment of surface water	2	0
Service reservoirs and water towers	Storage of potable water	31	32
Booster pumping stations	Reboosting of potable water	44	20

The following sections of this document will describe these assets in more detail and present the investment strategy and case studies to support the investment needs of these assets.

6.1 Groundwater Pumping Stations

The groundwater pumping stations are critical assets in the supply of water to customers in both the SST and CAM regions. It is essential that the Company maintains a level of resource availability that allows the delivery of resilient and high quality supplies to customers, both under normal operating conditions and when faced with unplanned and planned events.

The required level of resource availability for each region is set out in the individual Water Resource Management Plans for SST and CAM. This investment strategy is primarily concerned with the capital maintenance required to maintain this resource availability.

Groundwater pumping stations comprise a wide range of asset cohorts and each site has its own unique attributes, however in general the sites consist of the following high level asset cohorts:

1. **Boreholes and wells** are the physical structures drilled or built down into the ground from which groundwater is abstracted.

2. **Treatment plants** are the civil, mechanical and electrical equipment that is used to treat the groundwater to the strict water quality standards required for human consumption.

3. **Contact tanks** are the storage tanks that are used to provide the required disinfection to the treated water prior to forwarding into the distribution network.

4. **Pumping plant** is the mechanical and electrical equipment that is used to abstract the groundwater from deep within boreholes and wells; and to forward that water (once treated) into the distribution network.

5. **Buildings** are the physical structures on site that house the abstraction, treatment and pumping assets described above.

6.1.1 Boreholes and Wells

There are many boreholes and wells in service across the SST and CAM supply regions. They are constructed in different aquifers, with different groundwater quality, different geology and spanning a long period of time using different construction methods.

This variety means that a highly proactive approach is required for monitoring and maintaining these assets, to ensure that their longevity is protected for resilient and high quality supplies to customers now and in the future. The continued investment activity in boreholes and wells is a key contributor to the maintenance of stable serviceability for non-infrastructure assets over the short and long term horizon.

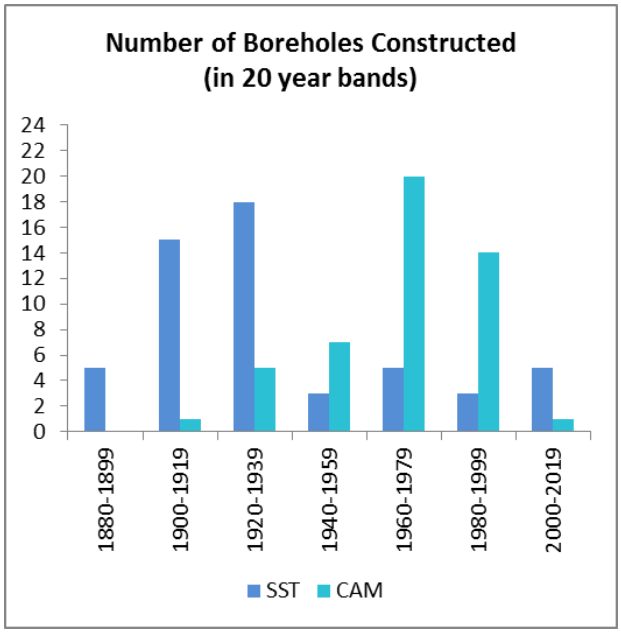
At PR09, the Company put forward a borehole replacement strategy starting in 2010 and continuing through an expected 15 to 25 year timeframe. This was intended to address a number of risks to groundwater supplies that had arisen over the previous 10 to 25 years as these assets got older and their condition deteriorated. This programme was implemented as planned within AMP5 and has been successful. The Company will have drilled four new boreholes by the end of AMP5, and remediated one borehole and one well. This has resulted in an improvement in water quality and reliability from the new assets in service. The activity also includes refurbishment of borehole headworks to protect against ingress from the surface, and the backfilling of poorly constructed observation and trial boreholes which provide a potential contamination path to the aquifer.

For assessing borehole risk and condition, the Company has adopted principles from the UKWIR study of Groundwater Asset Maintenance, which involved several water companies to study the principal failure modes which exist within the UK. The Company has developed sub threshold indicators for these failure modes as follows:

Failure Mode	Sub Threshold Indicator
Bacteriological	1, 2 and 3 day plate counts CCTV and geophysics surveys Headworks inspections
Turbidity and sand	In line turbidity monitoring Compliance sampling
Borehole collapse	CCTV surveys Borehole depth measurement
Borehole yield	Specific capacity trends
Iron and manganese	Compliance sampling

A tabulated data sheet has been created for each borehole where the risks are scored against these measures. Time series analysis is used to provide trends in these indicators and in overall condition, and to monitor the effect that historical interventions have had on the performance of a borehole. This information is used to determine the future monitoring and maintenance programme.

A continuing programme for borehole replacement and remediation is necessary to ensure that the Company can keep pace with the deterioration which is taking place and to ensure that replacement needs are not stored up for the future. The graph below shows the age profile of borehole structures in the SST and CAM regions.



The different construction profile between the two regions is evident in this graph.

The CAM region experienced large growth from the 1960s onwards and a large number of new greenfield groundwater sites were created in this period. This is contrasted by the SST region where the majority of construction occurred in the first half of the twentieth century driven by industrial growth. The boreholes in the CAM region are on average thirty five years younger than those in the SST region.

In the SST region, new borehole construction stopped abruptly post 1940, when the surface water treatment works at Seedy Mill and Hampton Loade were introduced.

The total capital maintenance expenditure on the borehole replacement strategy will be £2 million in AMP5. In AMP6 the Company requires £2.6 million to continue with the programme. This will allow the Company to drill four replacement boreholes, remediate one borehole and remediate two brick built wells. Additionally the Company will continue to undertake geological surveys on boreholes when the opportunity arises, to ensure that data on borehole condition is up to date and available to inform the ongoing strategy. Opportunistic surveys are undertaken on boreholes whenever pumping plant is removed for maintenance or repair as this is the most cost effective time to undertake these surveys.

6.1.1.1 Ashwood Pumping Station Case Study

Ashwood Pumping Station is an 18 Ml/d groundwater source located in the south of the SST region. There are six boreholes on the site constructed between 1892 and 1910. The site was originally steam powered and later converted to electricity.

Boreholes 1 and 2 were constructed first, around 1892. They are currently not operated due to nitrate levels above the PCV, and also air, turbidity and conductivity problems.

Boreholes 3 and 4 were constructed around 1900, and are the boreholes currently in service at the site running at 9 Ml/d each. Whilst these boreholes are currently below the nitrate PCV, the levels are rising and the trend is forecast to breach the 50 mg/l limit in 2020.

Boreholes 5 and 6 were constructed around 1910. The Company has no record of these boreholes ever being used, although there is physical evidence that pumps may have been in place at some point in the past. Initial surveys have suggested that these boreholes are predicted to be in a similar condition to the other boreholes on the site as they were constructed around the same period of time.

The source is critical to supply of water in the Springsmire Zone within the SST region. The present operating mode utilising boreholes 3 and 4 means that there is no standby capacity at the site should there be a failure.

CCTV surveys in February 2010 have shown the existing boreholes to be in poor condition with fissures present at various depths.

Several options and modes of operation have been considered for the site including remediation of the existing boreholes and several drilling options. Given the age and condition of the existing boreholes, and the critical nature of the site to its pumping zone, the most cost beneficial option is to drill two new boreholes on the site, away from the location of the other six. These will be constructed to modern standards with appropriate liners and will therefore improve current problems with air and turbidity. Locations have been selected which are assessed to be lower in nitrate levels although trial boreholes during the construction phase will confirm this. The provision of two new boreholes will reduce reliance on the current two older boreholes which will improve resilience of the site and allow greater flexibility in operation. The borehole drilling project is estimated to cost £996k and will be delivered in the middle part of AMP6.

6.1.2 Treatment Plants

All of the groundwater pumping stations have some form of water treatment process in place, ranging from simple disinfection through to complex nitrate removal processes.

It is essential that all of the treatment processes are effectively maintained to guarantee that water introduced into the distribution system is fit for human consumption and meets strict water quality standards. This requirement is not only part of the Company's operating license (enforced by the DWI), but also an area of service which customers rightly value very highly.

The table below shows a summary of the types of treatment plant installed across the groundwater pumping sites of both regions:

Treatment Process	Process Complexity	Current Number of Implementations (both regions)
Marginal chlorination	Low	19
Enhanced chlorination	Medium	22
Ultraviolet disinfection	Medium	3
Orthophosphoric acid dosing for plumbosolvency	Medium	27
pH correction	Medium	1
Sand removal (cyclonic)	Medium	1
Fluoridation (on behalf of the health authority)	Medium	18
Membrane ultrafiltration for cryptosporidium removal	High	2
Sand filtration	High	3
GAC filtration	High	2
Ion exchange for nitrate removal	High	6

Continued investment in these treatment plants will ensure that the groundwater pumping sites can continue to operate efficiently and safely. The Company's strategy has always been to undertake a range of operational maintenance practices and condition monitoring on a day to day basis using both experienced internal maintenance personnel and external contractor frameworks where necessary. Capital refurbishment projects are only undertaken when treatment plants have become deteriorated such that they present risks to the reliability or integrity of that treatment process.

Over the past 20 years, water treatment plants have tended to increase in complexity as they have become more reliant on complex automation and control systems. This is particularly the case with on line monitoring to ensure processes are operating within their design range and to provide ever more detailed telemetry data for compliance monitoring purposes. This tendency to become more reliant on technology has meant that many treatment plants contain automation systems which become obsolete in only a 10 to 15 year time frame. The Company makes every effort to maintain its equipment to provide the longest possible service life, however it is increasingly finding that equipment obsolescence is a key driver for capital investment in these assets.

There are some particularly large and complex treatment plants at some of the groundwater pumping stations which require specific consideration in this business plan.

6.1.2.1 Dealing With Nitrates Case Study

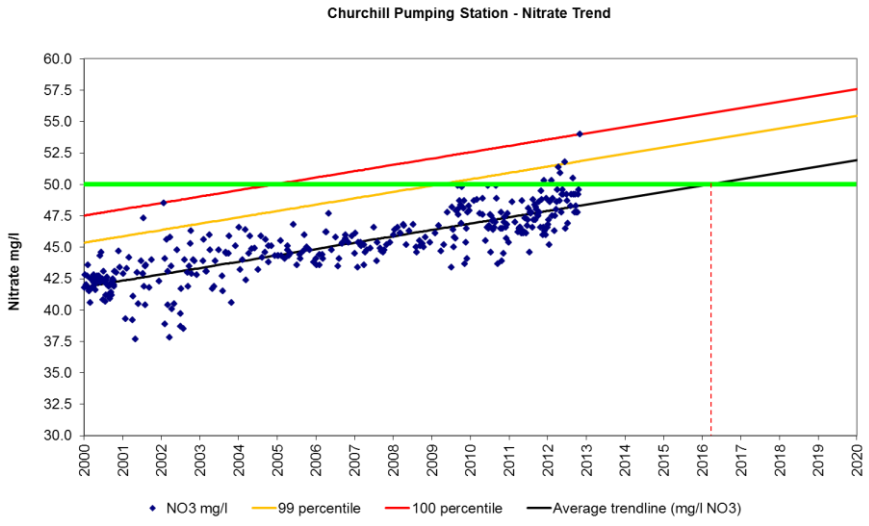
Many groundwater sites in the SST and CAM regions have high levels of groundwater nitrates as a result of fertiliser use by farmers over several decades. In both regions, a mixture of treatment and blending solutions are used to manage this issue.

In the SST region, a total of eleven groundwater sites are above the PCV for nitrate under normal operating conditions, and of these eleven sites, eight are blended with other lower nitrate sources before the water reaches customers. Three sites have ion exchange treatment plants which were installed in the early 1990's and are now at the end of their operating lives. The drivers for capital maintenance on these assets are as follows:

- High level of deterioration in condition across numerous component parts throughout the processes;
- High level of obsolescence with the control systems and automation used to monitor and control the treatment processes;
- The existing plants are highly inefficient particularly with regard to chemical consumption and effluent volumes generated by the processes when compared to modern plants;
- Operating modes within the network have changed substantially since the plants were constructed meaning that these treatment plants do not now respond well to the operating modes required from them; and
- The Drinking Water Safety Plan process has identified several plant deficiencies which could put final water quality at risk.

In short, when these plants are required to operate they cannot do so quickly or reliably; and cannot guarantee water quality integrity throughout the treatment process. The groundwater pumping sites where these nitrate removal plants are located are essential sources for the drought scenario within the SST Drought Plan and intervention is necessary to maintain the committed levels of service in this area. The replacement of these plants to maintain compliance is estimated at £5.8 million.

Also in the SST region, the Churchill Pumping Station is a groundwater pumping station, located slightly outside of the area of supply near Kidderminster, which has had nitrate levels in breach of the 50 mg/l limit and has a rising average trend. The graph below shows the trend since 2000 which has moved Churchill from being a compliant source to a non-compliant one:



Currently, to maintain the source into supply it is being increasingly blended with water from the Hampton Loade Water Treatment Works, however the average nitrate levels will rise and this arrangement in its current form will become non-compliant, leading to an inability to operate the source. The Water Resources Management Plan for the SST region includes the 10 Ml/d output from this groundwater site in the long term, and in order to sustain this, intervention is required in the short term. A number of options have been considered in detail, including continued blending, installation of nitrate treatment plants and the viability of catchment management. The most cost beneficial solution is for continued blending of the source, however for this to be viable a new trunk main needs to be laid to facilitate the higher blending volumes required as the average nitrate levels rise. This project is estimated at £1.2 million with an operating cost increase of £55k per annum due to additional pumping costs.

The Company has liaised extensively with its CCG and directly with the DWI on this particular groundwater source and has gained support for the project from the DWI. The DWI intends to issue a notice under regulation 28(4) of the Water Supply (Water Quality) Regulations 2000 that requires the Company to *"mitigate the risk of nitrate that has been identified as a potential danger to human health from the water supplied from Churchill"* and that *"it is expected that the Company* will *take all reasonable steps to prevent contraventions of the nitrate standard"*.

In the CAM region, nitrate trends are also increasing. In AMP5 the Company gained support from the DWI for dealing with rising nitrates at five of its groundwater sources. These commitments have been met through the construction of three nitrate treatment plants and two blending arrangements.

The issue of rising nitrate levels in the CAM region was not a one off AMP5 problem and further interventions are necessary in the short term and long term to continue to ensure compliance with the nitrate standard at the forecast demand levels. The forecast nitrate levels for 2015 and 2021 are shown overlaid onto the CAM region below:

The Company has received indication from the DWI that it intends to issue a notice under regulation 28(4) of the Water Supply (Water Quality) Regulations 2000 that requires the Company to *"mitigate the risk of nitrate that has been identified as a potential danger to human health from the water supplied from Fowlmere"* and that *"it is expected that the Company* will *take all reasonable steps to prevent contraventions of the nitrate standard"*.

Fowlmere Pumping Station is a groundwater source which has the highest nitrate levels in the CAM region at a forecast 76 mg/l in 2015. The source currently blends with two other sources before supplying customers. Fowlmere is the largest of these sources, supplying approximately half of the combined output from the three groundwater sites. Nitrate levels at Fowlmere are increasing and modelling shows that the blend arrangement will not maintain compliance with the 50 mg/l standard in all scenarios.

The company has evaluated the different options for complying with the DWI notice and has found that the installation of a Nitrate treatment plant provides the most reliable and cost effective method of achieving the requirement. The installation of a nitrate plant is estimated to cost £2.1 million with additional operating costs of £38k per annum.

In both the SST and the CAM regions, the Company is engaging in catchment management activity for the long term management of rising nitrate trends. The aim of this activity is to provide a sustainable and lower cost alternative to the current high cost methods of dealing with nitrates in groundwater through treatment.

In the SST region two groundwater catchments will be investigated (one of which is the Churchill catchment), to determine the viability of catchment management as a mechanism to reduce nitrate levels over the long term. In the CAM region the Company will continue to develop an approach to catchment management in two groundwater catchments (one of which is the Fowlmere catchment), where it is expected that benefits could be achieved, and will also conclude viability appraisal in a number of other catchments.

These catchment management implementation schemes and investigations are included in the Company's Water Quality NEP for both regions and appropriate funding has been included in the PR14 plan.

6.1.2.2 Cryptosporidium Removal Case Study

Cryptosporidium removal plants are present at two groundwater pumping stations in the SST region as a preventative measure at sites identified using a risk based approach (as advised by the DWI) where a risk of contamination may exist.

The Company installed membrane ultrafiltration plants in the early 2000's as part of the comprehensive quality programme driven by the changes in water quality standards (Water Quality Regulations 2000).

At the time, membrane ultrafiltration was the only DWI approved treatment process for dealing with cryptosporidium, however improved confidence in ultraviolet (UV) treatment processes since this time means that UV is now also an approved process. A detailed cost benefit analysis has been undertaken for switching from membrane treatment to UV treatment and it will be cost beneficial to make this change in AMP7, coinciding with the original design life of the membrane treatment plant. A UV treatment process is simpler to operate and maintain and does not result in any need for waste water treatment; so will therefore result in lower operating costs and lower operational risk than the existing membrane treatment processes. Subject to customers supporting this proposal in future

AMP7 consultations, this project is currently planned for implementation between 2020 and 2025.

6.1.2.3 Treatment Gas Independence in the CAM Region Case Study

The Treatment Gas Independence (TGI) programme has been ongoing in the CAM region since 2012. In the CAM region bottled chlorine gas and bottled sulphur dioxide are used for disinfection of potable water. In the PR09 business plan, Cambridge Water made the case for replacement of these gas dosing systems with liquid dosing systems and ultraviolet light disinfection due to the following drivers:

- The reliance on a single UK manufacturer for chlorine gas raised concerns for supply resilience under the Security and Emergency Measures Direction (SEMD);
- The rising costs associated with bottled chlorine and bottled sulphur dioxide; and
- The high health and safety risks associated with handling and storage of bottled chlorine and sulphur dioxide gases.

Using a risk assessment process the Company has assessed each groundwater pumping stations' dosing needs. This has resulted in reappraisal of ten sites from enhanced disinfection (currently delivered by the gas dosing systems) to marginal chlorination, which will be delivered through the installation of sodium hypochlorite liquid dosing systems. Seven sites still require enhanced disinfection and this will be met through the installation of ultraviolet light disinfection plant along with sodium hypochlorite liquid dosing to maintain the chlorine residual within the distribution system.

This work has already begun in AMP5 with a total of eight plants due to be completed in the period at a forecast cost of £2.2 million which was funded at PR09. A further sixteen plants will be completed in AMP6 at an estimated cost of £3 million.

In the SST region, all gas dosing systems at groundwater pumping stations have already been replaced with the equivalent liquid dosing systems.

6.1.3 Contact Tanks

Many of the groundwater pumping stations have contact tanks constructed on site to provide the appropriate disinfection time before the water enters the distribution system.

Contact tanks are inspected at least every four years, following the same rigorous inspection methodology as service reservoirs. The Company undertakes a thorough cleaning, civils inspection and hygiene inspection at these inspection outages. This is done using the same internal team who undertake the service reservoir activity led by the Company's internal Supervising Engineer. This robust process ensures that deterioration in these structures is detected early to ensure that deterioration is managed effectively.

6.1.4 Pumping Plant

The groundwater pumping stations have pump units for water abstraction, treatment and final delivery of treated water into the distribution network. The Company proactively manages its pumping plant assets through a thorough pumping efficiency programme. More detail on this industry leading activity, which covers pumping plant at groundwater pumping stations but also at surface water treatment works and booster pumping stations, is provided in Section 7.1: Energy Efficiency Programme.

6.1.5 Buildings

The groundwater pumping sites contain a variety of buildings which vary in age from the late 1800s through to today. These buildings provide the necessary protection and security to the pumping and water treatment equipment and are therefore assets which need to be maintained effectively. Many of the Company's buildings are historical landmarks in their local areas and some are also listed buildings, or anticipated to become listed following any applications to local planning departments. The Company believes in maintaining this heritage for the benefit of local communities and therefore always tries to accommodate the existing old buildings into its plans rather than following a knock down and rebuild strategy, if this is cost effective.

Buildings are long life assets and deteriorate slowly. The Company undertakes annual inspections of all of its buildings using an internal buildings management team and compiles reports detailing defects. These defects are monitored closely, using external consultant support where necessary, and interventions are undertaken when it is necessary to do so to maintain the integrity and safety of these structures.

This also includes the maintenance of physical and electronic security measures which have been fitted to many buildings under the Security and Emergency Measures Directive (SEMD) over the past fifteen years.

Building and security system maintenance across all of the Company's sites is allocated to the Management and General category, more information can be found in the Management and General Investment Strategy.

6.2 Surface Water Storage Reservoirs

The SST region has two surface water storage reservoirs supplying its two major surface water treatment works.

The first, Blithfield Reservoir, is an impounding reservoir of eighteen billion litres capacity, fed from the rivers Blithe and Tad and is located north of Rugeley in Staffordshire. It was constructed in the 1930s and 1940s. The dam is an earth dam with a puddle clay core. It is lined on the upstream face with concrete slabs to prevent erosion. The original draw off tower and spillway houses the pipework and ancillary equipment which supplies the treatment works at Seedy Mill. In the late 1990s a new spillway was constructed to provide the necessary overflow capacity in storm conditions.

The dam itself is in good condition, being only halfway through its expected lifespan. It falls under the Reservoirs Act 1975 and therefore is subject to annual inspection from the Company's internal Supervising Engineer and a ten year Section 10 inspection from an Inspecting Panel Engineer concerning dam safety. The reservoir embankment is monitored closely for any signs of movement.

Around the reservoir perimeter, some bankside erosion has occurred requiring the installation or refurbishment of gabions. This is necessary to prevent further erosion of the banks which, if left too long, would need more significant restoration. Some work on these deteriorated banks has already been undertaken in AMP4 and in AMP5, with further work in AMP6 estimated to cost £277k.

The second reservoir, Chelmarsh Reservoir, is a bankside storage reservoir of three billion litres capacity, located next to the River Severn and supplies the Company's Hampton Loade Water Treatment Works. The river intake at Hampton Loade abstracts raw water from the River Severn and pumps it into Chelmarsh Reservoir for storage and partial settlement. The treatment works then draws water from the reservoir. Chelmarsh Reservoir was constructed in the 1960s and is in good condition. It is an earth embankment dam with a puddle clay core. In AMP5 some remedial works have been undertaken on the slabs lining the upstream face, and minor repairs to the jointing on the concrete outlet tower. No further works are necessary for AMP6, although the reservoir is subject to the Reservoirs Act 1975 and therefore is inspected annually by the Company's internal Supervising Engineer and every ten years by an Inspecting Panel Engineer. Any defects found at these inspections are thoroughly investigated to ensure the ongoing safety of the dam structure.

The CAM region has no surface water storage reservoirs.

6.3 Surface Water Treatment Works

The Company operates two surface water treatment works in the SST region. In the south of the region, Hampton Loade Water Treatment Works, located on the River Severn, can supply up to 205 Ml/d. Central to the region, located near Lichfield but supplied by Blithfield Reservoir near Rugeley, is Seedy Mill Water Treatment Works which can supply up to 140 Ml/d. In average conditions these two treatment works provide around 60% of the supply to the SST region, which makes them both critical sources to meet the demand.

It is essential that the Company maintains these sites in a condition that allows the continued delivery of resilient and high quality supplies to customers, both under normal operating conditions and when faced with planned and unplanned events.

6.3.1 Hampton Loade Water Treatment Works

Hampton Loade Water Treatment Works, located on the River Severn near Bridgnorth in Shropshire, can supply up to 205 Ml/d of treated water into the SST region supply system. The average license is 183 Ml/d.

It was constructed in the 1960s as a joint venture between the Company and Wolverhampton Corporation (later absorbed into Severn Trent Water). On average license conditions, one third of the supply is exported to Severn Trent Water for supply to the Wolverhampton area, and the remaining two thirds supplying the SST region. Under the joint venture agreement, which exists in perpetuity, one third of the capital costs for the site are met by Severn Trent Water and a proportion of operating costs driven by the relative proportions of water supplied to the two companies.

Therefore, not only is Hampton Loade Water Treatment Works critical to the customers of the Company's own SST region, it is also critical to the customers of Severn Trent Water in the Wolverhampton area and the Company has a contractual obligation to Severn Trent Water to ensure this treatment works is appropriately maintained and reliable.

The treatment works itself is entirely self-contained. Raw water is abstracted from the River Severn by a dedicated river intake works and stored in Chelmarsh Reservoir located near the site. The treatment works draws water from the reservoir, passing it through several treatment processes until it is finally pumped off site into the supply system.

The treatment works has many processes and assets, from short life instrumentation, control and monitoring systems, high capacity pumping plant, to long life civil assets such as filters and clarifier tanks. There are also ancillary assets such as the high voltage power supply to the site with associated transformers and electrical equipment, on site standby generation for providing power resilience and the buildings which house all of this equipment and the site personnel. As can be expected, maintenance of a complex works such as this is a continual process and the Company has thorough processes in place to ensure that risks are assessed and monitored, and that interventions, whether capital or operational, are justified and managed appropriately.

In general, the level of capital investment undertaken at Hampton Loade Water Treatment Works has been stable since AMP4. In AMP3, between 2000 and 2005, the Company added additional treatment processes on site in order to comply with the Water Quality Regulations 2000.

The following case studies are presented in order to demonstrate some of the projects which make up the investment for the period 2015 to 2020.

6.3.1.1 GAC Regeneration Case Study

Regeneration of Granular Activated Carbon (GAC) filter media ensures that the rapid gravity filtration treatment processes at both Hampton Loade Water Treatment Works and Seedy Mill Water Treatment Works are effective in removing pesticides and other organics to ensure that the treated water meets the prescribed standards.

Regeneration of GAC is carried out by specialist contractors who visit the treatment works on a regular basis to remove the media. The media is then transported to a processing plant where it is heated to high temperatures in a furnace to remove the organic materials which have built up in the carbon granules during operational use. During the process, some carbon is lost (some is also lost during normal operation of the GAC plant), which is replaced with virgin carbon before the contractor returns to site to reload the filter with the regenerated GAC media.

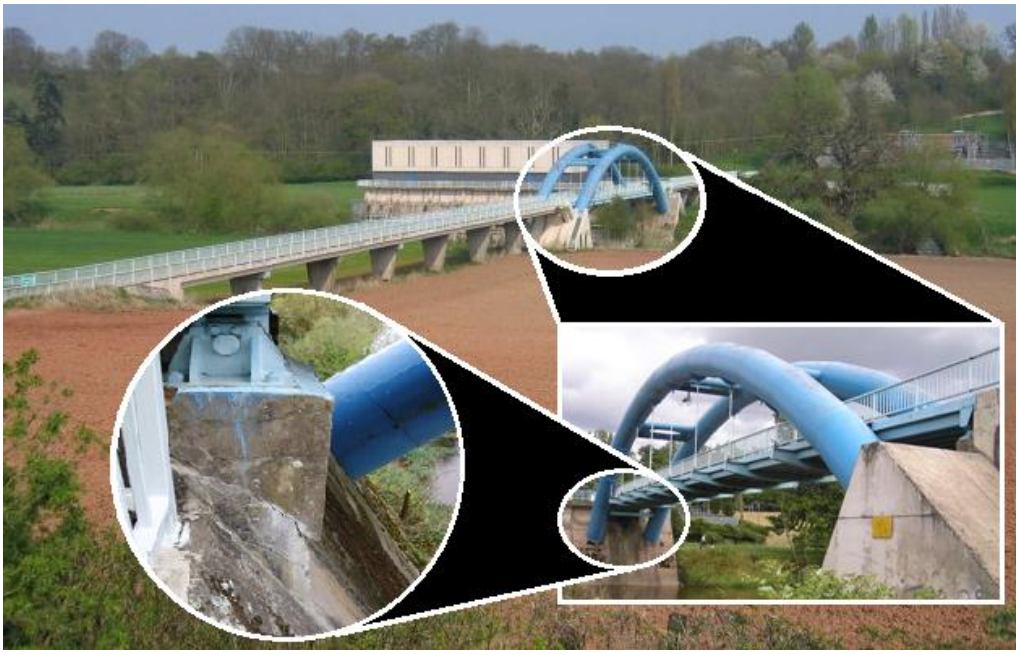
The media regeneration frequency is driven by the water quality performance of the filter media primarily in the removal of pesticides. The regeneration frequency is set to maintain a balance that ensures that treatment capacity is sufficient to deal with peaks in raw water pesticides whilst minimising the cost of regeneration as far as reasonably practicable. The current regeneration frequencies are six filters per year at Hampton Loade Water Treatment Works and seven filters per year at Seedy Mill Water Treatment Works, at a total cost of £1.1 million in AMP6. Water quality monitoring is undertaken on a regular basis to assess the risk from pesticides and degree of removal through GAC, to ensure the regeneration programme remains appropriate.

In September 2011, Grafham Carbons, the Company's supplier for GAC regeneration services, closed down their business. Grafham Carbons had consistently offered the most competitive prices in the market, which was partly due to lower operational costs for logistics due to their location within the SST region. As a result of their closure an alternative supplier, Cabot Norit located in Bristol, was selected and they commenced provision of GAC regeneration from January 2012. Although Cabot Norit were the most cost competitive supplier, an uplift of around 10% was immediately seen due to increased operational costs and different pricing structures. This has affected costs in AMP5 and followed through into AMP6 estimates.

6.3.1.2 Pipe Bridge Case Study

Located at the Hampton Loade Water Treatment Works in the SST region, the pipe bridge is an elevated road bridge providing a private crossing over the River Severn. The roadway is supported on bearings mounted to concrete plinths at each end of the bridge. The structure is also suspended from the sixty inch diameter raw water pipes which transport raw water to and from Chelmarsh Reservoir, which is the bankside storage reservoir fed by the intake works at Hampton Loade from the River Severn.

Surveys have highlighted cracking in the plinths which support the bridge bearings and spalling of the concrete on support piers. It is essential to undertake repairs on these structures in AMP6 to ensure the integrity of the bridge. The photograph below shows the extent of the issue.



The project is estimated to cost £400k.

6.3.1.3 Pumping Switchgear Replacement Case Study

At Hampton Loade Water Treatment Works a flood study has highlighted that electrical switchgear located in the basement of the high lift pumping building is at risk should there be a burst of the high pressure pipework contained within the basement. The switchgear was installed in this location in the 1960s when the building was constructed and the equipment is now obsolete.

This £80k project will replace the only remaining three switchgear units and relocate them to ground level. This is a continuation of work undertaken over the last ten years to relocate all the switch gear from the basement as and when the units have required replacement.

6.3.2 Seedy Mill Water Treatment Works

Seedy Mill Water Treatment Works, located near Lichfield in Staffordshire, can supply up to 140 Ml/d of treated water into the SST supply system.

Seedy Mill Water Treatment Works treats water from a mix of sources which all converge at the location of the works:

- **Blithfield Reservoir** is the Company's largest surface water reservoir located near Rugeley in Staffordshire. It supplies Seedy Mill Treatment Works via twin raw water mains. This makes up the bulk of the water supplying the works.

- **Seedy Mill Borehole** is located on the treatment works itself and supplies the works directly.

- **Trent Valley Pumping Station** is a remotely located groundwater site which is high in nitrates and pesticides and is therefore operated as a raw water input to the Seedy Mill site for treatment and blending.

The works itself was constructed in the 1940s and 1950s; however it has been substantially enhanced since its original construction and is a critical source in the SST region. The Seedy Mill works directly supplies four out of the twenty zones within the SST region, and indirectly impacts on several others. It has the potential to effect well over 200,000 properties covering a wide geographical area in the centre and north of the SST region.

The treatment works has many processes and assets, from short life instrumentation, control and monitoring systems, high capacity pumping plant, to long life civil assets such as filters and clarifier tanks. There are also ancillary assets such as the high voltage power supply to the site with associated transformers and electrical equipment, on site standby generation for providing power resilience and the buildings which house all of this equipment and the site personnel. As can be expected, maintenance of a complex works such as this is a continual process and the Company has thorough processes in place to ensure that risks are assessed and monitored, and that interventions, whether capital or operational, are justified and managed appropriately.

In general, the level of capital investment undertaken at Seedy Mill Water Treatment Works has been stable since AMP4. In AMP3, between 2000 and 2005, the Company added additional treatment processes on site in order to comply with the Water Quality Regulations 2000.

The following case studies are presented in order to demonstrate some of the projects which make up the investment for the period 2015 to 2020.

6.3.2.1 Replacement of Sulphur Dioxide Gas Dosing System Case Study

Over the past ten to fifteen years the Company has been replacing its gaseous dosing systems with liquid dosing systems, primarily for reasons of safety. This work has been undertaken in alignment with the normal replacement cycles for these types of assets to help keep bills low.

Sulphur dioxide gas is used for de-chlorination in the treatment process. It is a toxic gas requiring strict precautions to be taken on site including the use of atmospheric monitoring and the provision of breathing apparatus with appropriately trained personnel. The volume of

gas stored on site is enough to cause localised safety risks for personnel operating in the vicinity of the gas. Within the SST region, this is the last gas dosing system in operation. The condition of the dosing assets is now such that it is an opportune time to replace the gas system with a Sodium Bisulphite liquid dosing system which is much safer and will mitigate any future need to invest in atmospheric monitoring equipment, breathing apparatus and other specialist containment precautions on the site.

This project is estimated to cost £295k and will be delivered in the first year of AMP6.

6.3.2.2 Clarifier Refurbishment Programme Case Study

Within AMP5 the Company has started a programme of work to refurbish clarification tanks at the Seedy Mill Water Treatment Works. These assets were originally constructed in the late 1940s and have been substantially untouched since their original construction.

These assets were showing significant deterioration in a number of areas:

- Throughput had deteriorated as treated water quality from each unit was impaired beyond minimum flow conditions, restricting the reliable operating capacity of the treatment works as a whole;
- The internal ironworks were heavily corroded with some sections broken away;
- The variable speed brushgear drives had started to fail and were no longer serviceable, together with obsolete electrical and mechanical control gear;
- Operating performance and efficiency was impaired, associated with throughput restrictions, inefficient coagulant dosing and poor energy efficiency;
- Obsolete electrical equipment and inadequate handrails presented unacceptable safety hazards; and
- Unreliable flow metering and valve control.

Based on this poor condition the Company decided to undertake a phased programme of refurbishment. Within the AMP5 period two clarifiers will be refurbished with two more to complete in AMP6.

Each clarifier structure has a central stirrer which is suspended from its drive motor above by a single drive shaft.

The stirrers are original and have become heavily corroded, with some sections broken away. In general the entire stirrer unit is very weakened and at high risk of complete collapse.

This particular component is a bespoke part and lead times are in the region of six months to manufacture this single component.

Within AMP5 the Company will spend £894k on refurbishment of clarifier structures and has forecast to spend a further £700k in AMP6 on the remaining structures. The difference is partially due to expected cost efficiency which will arise from the experience gained in the AMP5 work to date; and also as there were some elements of the project which were required to be completed first yet which are common to all clarifier structures.

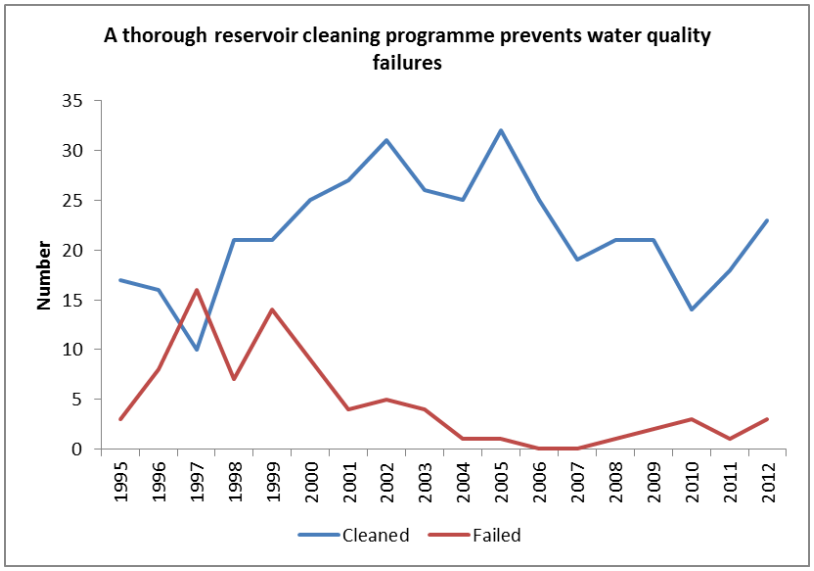
6.4 Service Reservoirs and Water Towers

The surface water storage reservoirs and water towers are critical assets in the supply of water to customers in both the SST and CAM regions. It is essential that the Company maintains these assets in a condition that allows the potable water to be stored without risk of contamination and without risk of structural defects, which could make a reservoir unsafe to operate. By their nature, service reservoirs have a low likelihood of failure however consequences can be severe.

Based on current average demand levels, the SST region has around 24 hours of storage which is amongst the lowest in the industry, and it is the high flexibility of the Company's network which facilitates this relatively low storage capacity. The CAM region has approximately 46 hours of storage based on average demand levels. These are region level averages but discrete areas within each region will vary.

The Company has a proactive inspection and cleaning programme which provides real benefits in terms of the ability to effectively manage these assets to low risk levels, and to quickly identify and mitigate any structural or water hygiene issues which may arise due to the deterioration of these assets. This thorough programme means that the Company has extensive first-hand knowledge of the condition of these assets now and the risks they pose to service now and in the future.

The effectiveness of the cleaning programme is shown in the graph below where an increase of cleaning frequency post 1997 has helped maintain excellent water quality performance since:



The Company will continue with this highly successful cleaning programme.

As shown in Section 5: The Regions; the SST region operates with a series of five large capacity service reservoir sites, containing eight individual reservoir structures, linked by trunk mains running from the south west to the north east of the region. These are shown in the table below:

Site	Reservoir	Capacity	Year of Construction	Age in 2015
Barr Beacon	Barr Beacon #1	46 Ml	1899	116 years
	Barr Beacon #2	44 Ml	1950	65 years
Gentleshaw	Gentleshaw	23 Ml	1930	85 years
Outwoods	Outwoods #1	18 Ml	1882	133 years
	Outwoods #2	18 Ml	1962	53 years
Sedgley	Sedgley	70 Ml	1971	44 years
Shavers End	Shavers End #1	25 Ml	1993	22 years
	Shavers End #2	32 Ml	1928	87 years
		276 Ml (73% of SST region total storage capacity)		**75 years** average age

Over the past ten years the Company has undertaken some major refurbishment work to some of its high capacity reservoir structures in the SST region and this need will continue indefinitely. Concrete and masonry structures will deteriorate and to protect the structural and water quality integrity of the reservoirs the Company must continue to maintain a level of investment to effectively deal with these defects as they arise.

In AMP5 significant internal structural refurbishments to both Gentleshaw Reservoir and Shavers End Reservoir #2 were undertaken to arrest the deterioration which was taking place. Roof membranes were retrofitted to mitigate against the risk to water quality caused by increasingly porous roof structures. Exterior surfaces were refurbished due to deterioration caused by exposure to the environment over many years.

For these refurbishment works the options available were considered in detail including rebuilding and postponement of investment. These projects were funded at PR09 and were delivered as high priority projects within the first two years of AMP5.

The CAM region operates in a similar way to the SST region, in that a series of interconnected service reservoirs runs from the south of the region where the majority of the groundwater sources are located, through the City of Cambridge to the north and west where smaller villages exist. Predominantly this is facilitated by the largest service reservoirs located at Cherry Hinton and several other strategically located sites. The table below shows the most strategic service reservoirs within the CAM region:

Site	Reservoir	Capacity	Year of Construction	Age in 2015
Bluntisham	Bluntisham #1	7.6 Ml	1982	33 years
	Bluntisham #2	7.6 Ml	1982	33 years
Bourn	Bourn #2	2.3 Ml	1963	52 years
	Bourn #3	4.5 Ml	1976	39 years
Cherry Hinton	Cherry Hinton #1	21.5 Ml	1967	48 years
	Cherry Hinton #2	5 Ml	1919	96 years
	Cherry Hinton #3	9.1 Ml	1939	76 years
	Cherry Hinton #4	23.5 Ml	1955	60 years
Coton	Coton #1	4.5 Ml	1961	54 years
	Coton #2	7.3 Ml	1972	43 years
Heydon	Heydon #1	4.8 Ml	1959	56 years
	Heydon #2	4.8 Ml	1970	45 years
Madingley	Madingley	20.2 Ml	1993	22 years
		123 Ml (86% of CAM region total storage capacity)		**51 years** average age

The CAM region has eight service reservoirs which were constructed using pre-stressed concrete, applied using circumferential and vertical post tensioning undertaken in-situ during construction. This method of construction became popular in the 1960s during the boom of high rise construction. It allows concrete structures to be lighter in weight as the strength of the concrete is increased through the pre-stressing process. This also means that the strength of the concrete is highly dependent on the integrity of the reinforcement and corrosion of the reinforcement over time can cause catastrophic failure of the entire structure. This occurred to a reservoir of similar construction at Lanner Hill in Cornwall in 1999, when corrosion of the circumferential pre-stressing meant that the structure was unable to support the weight of the roof.

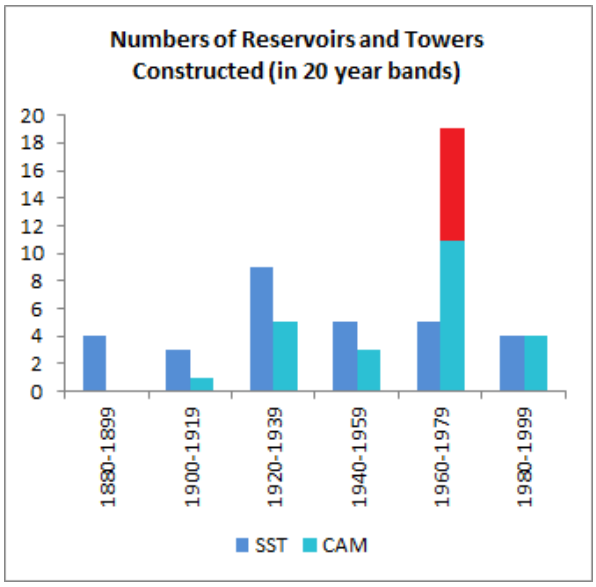
Since 1992, reservoirs constructed using this method in the CAM region have suffered failures of individual pre-stressing wires. The solution has been to remove or replace the pre-stressing wires. It is essential that regular inspections are carried out to check the condition of the circumferential wires, anchorages and protective grouts to ensure that the structure is not weakened. The Company uses external consultants to provide expertise in the examination and monitoring of these structures. An article from the Water Active industry magazine explains the issue:

"Instances of pre-stressing wire failure, however, have been fairly common. But it was not until December 1999, when the domed roof of one tank collapsed at Lanner Hill in Cornwall, that a catastrophic structural failure was reported. Since then there have been further sudden and disastrous failures as such structures continue to deteriorate. The failures are presenting significant safety, environmental and financial risks to the water industry and have resulted in an initiative to inspect and repair these tensioned structures as a matter of urgency."

Water Active Article, February 2009

For the future, there are some very significant risks related to three large reservoir structures in the SST region; namely Outwoods Reservoir #1, Barr Beacon Reservoir #1 and Shavers End Reservoir #2. Two of these reservoirs are well over one hundred years old. For the first time in twenty years the Company is proposing reservoir rebuilds following the extensive options appraisal that has been underway for almost two years. In the CAM region the pre-stressed reservoirs require an ongoing monitoring and maintenance regime, and reservoirs of other construction types are approaching ages where they begin to experience marked deterioration of concrete surfaces, metal works and suffer from increased roof porosity.

The Company is approaching an era where reservoir replacement will become an increasing requirement of capital maintenance expenditure. The age profile for all service reservoirs and water towers in the SST and CAM regions is shown on the graph below.



The construction profile in the SST region and the CAM region is markedly different.

Construction in the SST region was driven predominantly by growth in the first half of the twentieth century, whereas in the CAM region construction was driven by very fast growth in the 1960s and 1970s, during which period nineteen new reservoirs were constructed.

The red bar shows the group of eight high risk pre-stressed reservoirs in the CAM region. These were all built in the 1960s and 1970s and with a lifespan of only 50 years, these structures will require intervention in the short term horizon.

This construction profile, together with predictive modelling, means that it is predicted that at least one reservoir per AMP will require significant refurbishment or reconstruction in either the SST or CAM region, to keep pace with the deterioration which is taking place and to ensure that replacement needs are not stored up for the future. This strategy will need to be ongoing and will take into account local needs and the condition of the individual structures on a case by case basis. Refurbishment rather than replacement will continue to be the preferred option where it is economic to do so without risks to safety, water quality or supply reliability.

Case studies of specific projects to be undertaken in AMP6 and AMP7 follow.

6.4.1 Outwoods Reservoir #1 Case Study

This reservoir in the SST region was originally built in 1882 making it 133 years old in 2015. It is one of two reservoir structures on the site with the second, newer, reservoir being built in 1962 because of growth experienced in the region.

Detailed structural surveys have been undertaken using external consultants AMEC and Atkins alongside internal expertise from the Company's resident Supervising Engineer. AMEC were appointed to undertake the detailed internal inspection surveys on site and Atkins were appointed to provide detailed expertise on modern design standards and methods to quantify and judge the risk to structural safety given the defects identified. Atkins are also the Inspecting Panel Engineer providers for the statutory 10 year inspections required under the Reservoirs Act. Both consultants have extensive experience with old and new reservoir structures within the industry.

Outwoods Reservoir #1 is primarily of brick and concrete construction, with a mass concrete floor and brick walls lined with puddle clay on the exterior. The roof uses a large number of cast iron beams which support brick barrel vaulted arches, these being covered with a concrete screed. A number of severe structural defects were identified with this reservoir structure. The Atkins report makes the following comments:

> *"The reservoir clearly has severe problems with the integrity of the roof beams and repairs on this scale would appear to be questionable. In addition, even following repairs the reservoir would still have a high residual probability of failure due to other unsatisfactory elements in the construction which mean that the reservoir does not meet current standards and best practice."*
>
> *"The cracking of 30 of the cast iron roof beams indicates a fundamental flaw in the design of the roof, or the life span has been exhausted. This will have significantly reduced the structural integrity of the roof and so the need for any works / inspection inside the reservoir should be carefully considered in future. Temporary props may need to be installed as an additional safety measure for internal works / inspection to be undertaken safely. We understand that personnel have been ordered to stay off the reservoir roof and under no circumstances is plant to be taken onto the roof or the embankment slopes. These precautions are essential."*
>
> *"Works to repair the roof beams may be suitable in the general short term however could be considered a patch repair and ultimately the roof would need to be completely demolished and replaced with a new roof."*
>
> *"I believe it is quite clear that repair is not an acceptable solution and that replacement should be seriously considered as the only way of moving the company to a position where it is measuring an acceptable risk."*
>
> Dr Andy Hughes, Atkins, 6th June 2013

A detailed options appraisal has been undertaken and the costs and benefits of replacement and refurbishment compared. The analysis also considered the optimum storage capacity required to ensure customer supplies remain resilient. The location of this reservoir site, in Burton upon Trent in Derbyshire, is one of the few areas of the SST region predicted to experiences positive growth in the future. Due to the condition of this reservoir and its obsolescent method of construction, the most economic option is to demolish and rebuild the structure to modern standards.

The project construction phase will commence early in AMP6 due to the high risk of structural failure. An internal project team and steering group for this large project is already set up and progress has begun on the preliminaries and enabling works, including:

- developing the programme of works;
- extensive liaison with the local planning authority;
- undertaking the environmental surveys;
- developing plans for supply resilience in the zone during the construction phase; and
- developing the procurement strategy and initial engagement with possible design and construction contractors.

This essential project is on target for completion within the first two years of AMP6 at an estimated cost of £4 million.

6.4.2 Barr Beacon Reservoir #1 Case Study

This reservoir in the SST region was originally built in 1899 making it 116 years old in 2015. It is one of two reservoirs on the site with the second, newer, reservoir being built in 1950 alongside the construction of the Seedy Mill Water Treatment Works during the late 1940s and early 1950s. The structure was originally built as an open reservoir using earth embankments, however a short time later in 1902 it was covered with a concrete roof. Due to its size, this reservoir is subject to the Reservoirs Act 1975 and requires an annual inspection by the Company's Supervising Engineer and a 10 year inspection by a Supervising Panel Engineer.

Detailed structural surveys have been undertaken using our external consultants Atkins, who also provide the Inspecting Panel Engineer for this statutory reservoir under the Reservoirs Act 1975. A number of structural design concerns were identified with this reservoir structure. The Atkins report makes the following comments:

> *"The development of the construction of the reservoir has been in a piecemeal way and as such the structure is not in a form that could in any way be described as best practice and the most useful means of measuring performance, leakage measurement, is not being monitored. This, together with the fact that the fill is non-cohesive, means that the mode of failure could be rapid and virtually impossible to arrest."*
>
> *"The reservoir does not meet best practice standards, and can never do so, and the form of construction is such that it cannot be properly overseen in terms of reservoir safety. Should a failure or major incident occur it would be very difficult to defend the situation."*
>
> Dr Andy Hughes, Atkins, 6th June 2013

Due to the construction method for this reservoir the Company's view, supported by the Inspecting Panel Engineer, is that it is simply not technically possible to refurbish this reservoir in such a way to remove the risks associated with an earth embankment dam in this location, and that the existing structure is not fit for purpose for continued use. Whilst the structure has not been officially condemned as part of the Reservoirs Act inspection process, the Company has already been obligated to undertake some immediate safety modifications (now completed) and to increase the monitoring regime of the embankment structure.

A detailed options appraisal has been undertaken and the costs and benefits of replacement and refurbishment compared. The analysis also considered the optimum storage capacity required to ensure customer supplies remain resilient. This reservoir is jointly the largest single compartment within the SST region and acts as a significant conduit to transfer water between the south and north of the region, an essential operational practice for efficient operation of the integrated network. It is also a key asset in the SST region's worst case scenario. Due to the condition of this reservoir and its obsolescent method of construction, the most economic option is to demolish and rebuild the structure to modern standards, at an estimated cost of £7 million.

The initial proposal was to rebuild this reservoir towards the end of AMP6, immediately following the completion of the Outwoods Reservoir #1 rebuild. Throughout the process the Company has been in continual discussion with the CCG concerning the AMP6 projects and they made a challenge on whether this construction could be deferred until AMP7 to help with affordability. The risks associated with this deferment have been carefully reviewed. The Company has already implemented an increased monitoring plan which will be maintained throughout AMP6, and there are also some preliminary works to the adjoining reservoir #2 on the same site which will still need to be undertaken prior to removal of #1 reservoir from service. On this basis CCG challenge was accepted. If monitoring identifies that the condition of the reservoir has deteriorated, or is deteriorating rapidly, then the deferral decision will have to be reviewed quickly due to the high risks involved with this reservoir structure.

6.4.3 Shavers End Reservoir #2 Case Study

This reservoir in the SST region was originally built in 1928 making it 87 years old in 2015. It is one of two reservoirs on the site with the second, newer, reservoir being built in 1993 to replace the previous reservoir which was 150 years old at the time of its rebuild. The structure is an unusual design, being mostly raised above the surrounding ground level and predominantly of steel and concrete construction. Due to its 32 Ml size, this reservoir is subject to the Reservoirs Act 1975 and requires an annual inspection by our Supervising Engineer and a 10 year inspection by a Supervising Panel Engineer.

Over past annual inspections it has been identified that sections of the structure were experiencing significant deterioration, which was supported by the Inspecting Panel Engineer when the Section 10 inspection was carried out in 2009. An extract from the Section 10 report states the following:

> *"Given the age of the structure and the risk that it poses, it would be prudent for the Undertaker to start planning for the replacement of this reservoir within the next 10-20 years."*
>
> A L Warren CEng FICE, Halcrow Group Ltd, May 2009

A detailed options appraisal has been carried out considering how the site is operated and whether the significant volume of storage is necessary in that location. The reservoir site is located in an area of the region which has experienced marked decline in industry and associated reductions in demand, although the reservoirs themselves are still heavily utilised as part of the system of highly interconnected reservoirs. A number of high volume borehole sources pump directly into these reservoirs.

The analysis showed that replacement of this structure will not be necessary in the future provided there is sufficient storage at the Barr Beacon Reservoir site. The proposal is to replace the severely deteriorated structure of Barr Beacon Reservoir #1 and these works will then enable the future abandonment of Shavers End reservoir #2 in approximately 10 to 15 years' time. The other reservoir on the site, reservoir #1 built in 1993 with twin compartments, is sufficient in capacity to supply the customers within the zone and provide the throughput required to transfer water supplied by groundwater sites in the south of the SST region to the north via the Barr Beacon reservoirs.

6.4.4 Bourn Reservoir #2 Case Study

This reservoir in the CAM region was constructed in 1963 making it 52 years old in 2015. It is one of a number of pre-stressed concrete reservoirs operated in the CAM region. It is circular in plan, with the concrete walls being 200mm thick and pre-stressed through the in-situ application of circumferential and vertical post tensioning. The circumferential post tensioning wires are 5mm diameter high tensile steel continuously wound from the bottom to the top of the walls. The winding density is variable to cater for different stresses at different heights in the walls, for example the hydrostatic head from the water inside, the weight of the domed roof and wind loading.

In 1992 following reports of a number of failures of the post tensioning wires at similar reservoirs, a specialist contractor, Postensioned Structures Ltd, were commissioned to carry out extensive in service examinations of the structure to determine its general structural condition. The investigations included inspection of the gunite overlay looking for voids (which is the source of corrosion of the post tensioning wires), evidence of rust staining and calcite deposits. The results of this inspection were generally good, with only two areas of corrosion found and minor remedial works were carried out.

In 2012 a further inspection was undertaken, which uncovered extensive corrosion to the circumferential post tensioning wires. Although the rest of the structure was in good condition, the extent of corrosion on the wires was a significant concern and the reservoir was taken out of service due to the risk of catastrophic failure. The photographs below show the corrosion of the post tensioning wires:

To restore the asset to service will require installation of new post tensioning wires along with new overlay material at an estimated cost of £305k.

6.5 Booster Pumping Stations

The booster pumping stations are critical assets in the supply of water to customers in both the SST and CAM regions. It is essential that the Company maintains a high level of reliability with these assets that ensures continued resilient supplies to customers, both under normal operating conditions and when faced with unplanned and planned events within either region.

The Company operates a classification system for booster pumping stations used to define the function they perform within the distribution system.

Category	Description
Category 1:	**Runs 24 hours per day to maintain supplies to customers.** These sites are the most critical booster sites as they directly feed customers using pressure control automation. The Company's policy is to ensure these sites are resilient by installing duty standby pumping plant, emergency power generation and mobile pump connections.
Category 2:	**Runs less than 24 hours per day to maintain supplies to customers.** This category is almost identical to category 1 above, except that it is not necessary to maintain 24/7 running. Sites usually run for most of the day with the sites not required at night.
Category 3:	**Running for any length of time to replenish storage.** These sites are essentially transfer boosters used to fill the smaller local reservoirs and towers from the trunk mains system. In the event of failure there will normally be a resilience period of several hours provided by local storage.
Category 4:	**Running for any length of time to maintain pressure to customers.** These booster sites tend only to operate during peak times. They provide a small pressure boost to the downstream network ensuring that pressures at the customer taps are meeting the minimum standard.
Category 5:	**Transfer or backup and no customer impact under normal conditions.** This category is used for strategic transfers within the trunk mains system. These sites do not directly impact on customer supplies from day to day, however they are still critical sites for the operation of the distribution network as they allow bulk transfer of water between the larger reservoirs or provide backup supplies to the supply zones. Without these sites the network would be much more restricted, especially in extreme circumstances and this could lead to customer supply issues.

Typically the booster pumping stations contain pumping plant, electrical equipment, automation and telemetry equipment, a standby diesel generator and the building itself.

In AMP5 the Company spent around £3 million on booster site refurbishment including the construction of two new booster stations to improve supply resilience in specific zones. In AMP6 the Company will spend £1.7 million across both regions. These interventions are necessary to ensure the continual reliable operation of booster pumping stations for the movement of water around the networks and supply to customers.

7. Energy Efficiency Programme and Utilisation of Renewable Energy

7.1 Energy Efficiency Programme

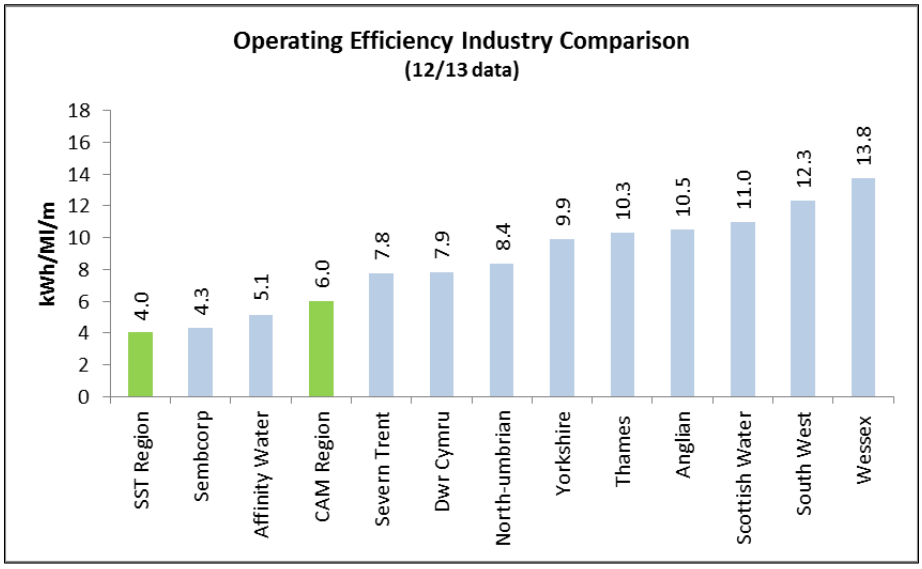
Within the SST and CAM regions the Company has over 300 operational pumps associated with the abstraction of ground and surface waters; and the supply of potable water into and around the Company's distribution networks. Pumps range in size from approximately 5 kW up to 1,500 kW. It is necessary to undertake performance testing and refurbishment of these pumps to maintain optimum energy efficiency.

The Company typically pumps 150,000 Ml of water into its distribution system annually. Of this total, 124,000 Ml is supplied in the SST region where the topography requires it to be lifted by an average of around 200 metres. This is higher than any other UK water company. Water supplied in the CAM region is pumped to an average head of 96 metres.

The electrically driven pumping plant performing this function consumes over 100 GWh of grid electricity per year which is 90% of the Company's total electricity consumption. This represents an operating cost of over £8.6 million per annum which is forecast to rise to £10.6 million by 2020 due to energy price rises. For this reason the efficiency of pumping plant and its rate of deterioration is monitored closely. The Company has a detailed performance testing programme where all pump units are tested on frequencies of between 1 and 5 years depending on the size of the pump unit.

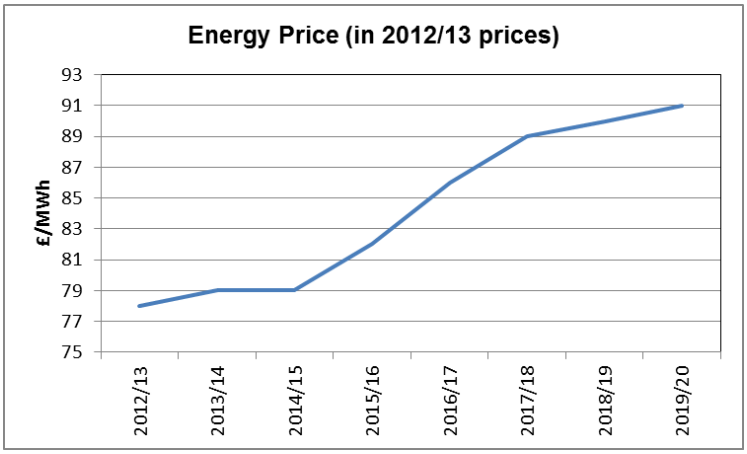
The weighted average efficiency decay across all pumps is calculated to be 0.56% per annum. Without intervention to maintain the pumping efficiency, energy consumption would increase at a rate of around 0.85 GWh per year with a corresponding increase in operating cost.

The industry measure of pumping efficiency is kWh/Ml/m which is the amount of energy required to lift one mega litre of water by one metre. A Company average is calculated annually and also internally for each pump as they are tested. The graph below shows a comparison of kWh/Ml/m for the SST and CAM regions against the other water companies where the data was available. This shows the SST region to be the most efficient, a position it has consistently held and reflects investment in pumping efficiency improvement over a number of years. The CAM region is also performing well and will continue to improve as cost effective targeted pump refurbishment is undertaken.



Maintaining this level of performance is cost effective. In the last year of AMP4 (2009/10), the efficiency statistic for the SST region was 4.12 kWh/Ml/m. This had dropped to 4.00 kWh/Ml/m by year 3 of AMP5 (2012/13), representing a net efficiency improvement of 1.48%, When normal decay is added, this represents a gross improvement of 3.16%. This improvement has been delivered through an investment over this time frame of £916k with a corresponding energy saving of £120k per annum.

The price of energy is forecast to rise in real terms over the AMP6 period from 2015 to 2020. A report commissioned from *Bergen Energi* and *Cornwall Energy* by a number of water companies specifically for PR14 discusses how the component parts of the outturn cost of energy are predicted to change. This report has been used to produce the graph below which shows actual and forecast energy prices in real terms from 2012/13 to 2020.



Over the period shown the price of energy is predicted to rise significantly with a real terms increase of 17%, and within that the third party charges (non-energy component) is forecast to rise by 64%.

Since 2011 the Company has been reporting carbon emissions under the Carbon reduction Energy Efficiency Scheme (CRC) and since 2012 allowances have been purchased to cover these emissions. Each allowance corresponds to a tonne of carbon dioxide arising from consumption of grid electricity. In phase 1 of the scheme each GWh equates to 541 tCO_2 and each allowance costs £12. Phase 2 commences in April 2014 when allowances will be charged at £16 per tCO_2, a 33% increase in cost.

7.2 Utilisation of Renewable Energy

The Company has undertaken detailed investigations into the provision of renewable energy within its regions. Initially investigations were focused on installations of wind turbines with the key criterion being that most of the energy generated must displace grid electricity consumption of an asset operated by the regulated business. Having examined a number of sites none were suitable, either because of insufficient wind speed or proximity of dwellings.

Solar photovoltaic (PV) technology was then assessed and a number of potential suitable locations for its installation were identified with support from a specialist contractor, *Myriad CEG*. The table below shows a summary of the Company's investigations.

Capacity	25 kW	50 kW	100 kW	150 kW	200 kW	500 kW	1000 kW
Estimated Capital Cost	£27k	£54k	£80k	£120k	£126k	£291k	£581k
25 Year Maintenance Costs	£18k	£20k	£25k	£45k	£50k	£95k	£145k
Feed in Tariff	11.73p	11.73p	9.99p	9.55p	9.55p	6.85p	6.85p
25 Year Gross Income	£100k	£200k	£372k	£547k	£730k	£1,612k	£3,223k
Payback Period (Years)	8.3	7.5	5.8	6.0	4.6	4.8	4.7

A survey of the sites showed that it is possible to install 25kW solar PV plant at three locations; 50kW at one; 100kW at three; 200kW at one; and 500kW at one. This would give a total installed capacity of 1125kW. The table below gives a breakdown of the costs associated with this investment and corresponding income and carbon emissions savings.

Total Installed Capacity	1125 kW
Estimated Capital Cost	£792k
Energy Generated	905,814 kWh
Annual Maintenance Costs	£12k
Annual Energy Costs Saved	£96k
Annual Feed in Tariff Income	£81k
Annual Tax	£20k
Annual Net Income	£147k
Payback	5.4 years
Annual Operational Emissions Saved	453 tCO_2/yr

The energy saving is based on the predicted delivered energy and current electricity tariffs. The feed in tariff (FiT) income is also based on the delivered energy and the FiT at the time the analysis was undertaken. FiT is a subsidy that can be claimed for every kWh of energy generated. Different rates of FiT apply to different technologies and capacities and these are periodically adjusted according to a regression mechanism described in legislation.

The technology also reduces operational CO_2 emissions and gives long term price certainty for a proportion of the Company's electricity consumption.

8. Engagement and Challenge with the CCG

The Company's plan for maintaining the water quality compliance and serviceability of non-infrastructure assets in AMP6 has been through many iterations of challenge internally, using the Company's own processes, and externally using the Customer Challenge Group (CCG) directly.

During the course of the CCG meetings, the group decided that some elements of the Company's capital maintenance plan would benefit from additional scrutiny by an engineering professional with experience in dealing with technical engineering projects. The Company welcomed this suggestion as it was an opportunity to validate the outcomes of the Company's thorough asset management processes and the engineering needs of the asset base going forward.

The CCG appointed Mr M. Reid of Monson, who was previously the Company's regulatory reporter. Mr Reid has extensive knowledge of the Company from his previous regulatory auditor role and this meant that he was well placed to provide the CCG with an efficient service and robust scrutiny of key elements of the Company's maintenance plan. Mr Reid was appointed by the CCG, not by South Staffs Water, and he was accountable to the CCG during the period of scrutiny.

The tables below list the challenges relevant to this section of the capital maintenance plan which have been made either from the CCG directly or from the engineering scrutiny audit, along with the Company response.

CCG Challenge
Can some expenditure be deferred until after 2020?
Company Response
Much proposed expenditure has been deferred, with only essential spends on assets to go ahead in this period. An independent review of expenditure is being carried out on behalf of CCG by Mike Reid of Monson Engineering
CCG Position
Following the independent review and subsequent challenges made through the CCG the group welcomed the deferment of work such as the replacement of Barr Beacon Reservoir until AMP 7.

CCG Challenge
Is it possible for investment to rise, but bills to fall through efficiency improvements and better targeting?
Company Response
Action is being taken to minimise the increase, for example, by deferring some capital expenditure. The company has stretching efficiency targets in the next AMP and is balancing all elements of its plan to keep bills as low as possible whilst meeting customer needs confirmed through customer research.
CCG Position
Agreed that appropriate action is being taken, including the improved targeting of capital maintenance work.

CCG Challenge

Is spending on nitrate removal simply a way to secure extra capital spend?

Company Response

Research has shown that water quality is the top priority for customers. Without this capital spending, water quality standards may not be met. In addition, the benefits of relevant technology would be lost and more expensive alternative water sources may have to be used.

CCG Position

Agreed, the CCG recognises that the new nitrate plant at Fowlmere has DWI support and is pleased that the number of nitrate plants to be replaced has reduced from 3 to 2.

CCG Challenge

Consider equalising the likely spend on reservoir replacement in AMP 6 with that in AMP 7 by undertaking the work at Barr Beacon No 1 across both AMPs, and thereby reducing the effect on customer's bills in AMP 6.

Company Response

We have reviewed the risks associated with deferring Barr Beacon into AMP 7. Providing an increased monitoring plan is maintained throughout AMP6, and the associated enabling works are delivered within AMP6 to allow an AMP7 year 1 start, the deferral of Barr Beacon is currently considered acceptable. If however the monitoring plan identifies that the condition of the reservoir has deteriorated further this deferral decision will need to be reviewed.

CCG Position

Accepted.

CCG Challenge

Consider the asset life at Bourn No 2 reservoir after refurbishment and replacement and from that determine the best value option for customers. Look at options at St. Ives reservoir which would allow for regular inspection and maintenance of the existing reservoir and provide for a second feed to zones served by that reservoir.

Company Response

Asset life for a refurbishment is conservative as would be expected to protect the supplier from guarantee and warranty exposure. It is extremely likely looking at the proposed engineering solution that a significantly longer life will be achieved. The Bourn supply zone is earmarked for significant further development in the next 15 years (i.e. within the guaranteed life of the refurbishment works) which will provide the opportunity to potentially reinforce the network and review security of supply to the Bourn zone. The proposed St. Ives Res. works include provision for a second feed into the zone currently discretely supplied by the single reservoir at St. Ives.

CCG Position

Accepted. Pleased to see that a second feed is to be provided to the St Ives zone which means that the reservoir can be temporality bypassed to allow for inspection and maintenance.

CCG Challenge
To produce a model showing operating cost savings from each of the sources when the nitrate plants have been replaced and equate that to total opex saving in AMP 6. Also, see possible challenge on level of overall investment programme.
Company Response
Model based on data from Cambridge nitrate plants commissioned during AMP5, indicates that this approach is totex cost beneficial.
CCG Position
Accepted.

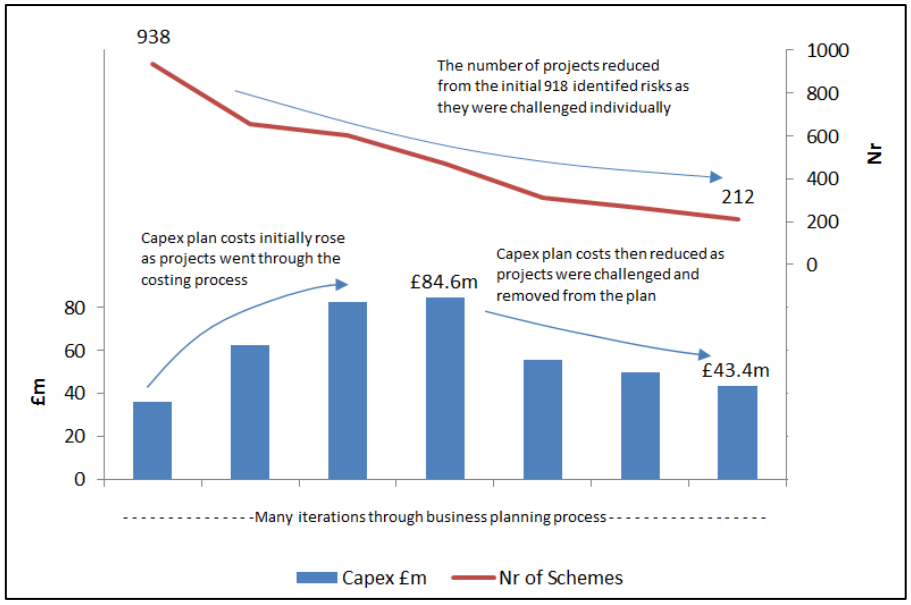
CCG Challenge
If the DWI issues an undertaking then the proposal for a new nitrate plant at Fowlmere could become a requirement. The challenge would then be what alternative options do they have should planning permission not be granted for a plant at the present Fowlmere site.
Company Response
In short, none. It is not automatically the case that the site is green belt and therefore at risk of planning application decline. Green belt is Cambridgeshire is a ‘donut’ around the city and this may be outside of the prescribed area. We could/would legally challenge planning as we did at Fleam Dyke several years ago on the basis that there was no alternative.
CCG Position
Accepted on the basis that any additional costs are borne by the Company without increasing customer bills.

CCG Challenge
If the DWI issues an undertaking then the proposal for a new nitrate plant at Fowlmere could become a requirement. The challenge would then be what alternative options do they have should planning permission not be granted for a plant at the present Fowlmere site.
Company Response
In short, none. It is not automatically the case that the site is green belt and therefore at risk of planning application decline. Green belt is Cambridgeshire is a ‘donut’ around the city and this may be outside of the prescribed area. We could/would legally challenge planning as we did at Fleam Dyke several years ago on the basis that there was no alternative.
CCG Position
Accepted on the basis that any additional costs are borne by the Company without increasing customer bills.

CCG Challenge
On the level of risk taken in its above ground assets programme if the concern is that the overall investment programme for AMP 6 is significantly higher than in AMP 5 and areas need to be sought for savings in the short term (next five years).
Company Response
The increase in expenditure is due to the need to undertake the nitrate plant refurbishments and the reservoir replacements. The remainder of the programme is in line with expenditure in AMP5. We have taken a pragmatic approach with our bottom up identification of risks process and have been through several iterations of our baseline maintenance expenditure. Our process ensures that our plan is the minimum level of spend necessary to ensure secure, reliable and regulatory compliant supplies from the above ground assets during AMP6. The delivery of the overground schemes specifically nitrates schemes have been programmed for AMP6 to ensure there is minimum risk to customer service. The programme reflects all work including programmed maintenance such as reservoir cleaning and consideration has been made with regards to strategy storage and maintaining appropriate deployable output levels to reduce any risks to customer service.
CCG Position
Accepted that level of risk taken in approach to AMP 6 programme is at or about that taken in AMP 5 particularly now that the number of nitrate plants to be replaced has reduced from 3 to 2.

CCG Challenge
To review the need to replace all sample lines at the proposed frequency given the very significant uplift in expenditure, and consider a smaller step change with monitoring to check acceptability of that less frequent replacement frequency.
Company Response
The company has previously replaced sample lines as a low priority following failures of samples attributed to sample lines. The DWI has given messages that sample lines cannot be used as an excuse for failures and there is greater emphasis/scrutiny on a Company's approach to maintenance of sampling facilities. The Company's proposed frequency is based on targeted performance monitoring of sample facilities and the likelihood of a failure if the sample lines are not replaced.
CCG Position
Accepted that increased frequency is required but would advocate a review of replacement regime during AMP 6 to ensure that the most cost effective replacement programme is being followed.

As shown in Section 3: The Asset Management Approach, the Company has been through many iterations of its capital maintenance plan. The chart below shows how the number of projects reduced from 938 risks to 212 confirmed projects through the Company's robust processes and investment optimisation approach. Peak capital expenditure was £84.6m which reduced to £43.4m through continual reassessment of project needs.



The CCG challenges are included in this process. Challenge from the CCG has directly resulted in the deferral of Barr Beacon Reservoir into AMP7 worth approximately £7 million, and one nitrate plant has also been deferred worth around £2 million.

9. Summary of Capital Maintenance Requirements in AMP6

This plan for Maintaining the Water Quality Compliance and Serviceability of Non-Infrastructure Assets is the result of several years of investigations to understand risks to service of the water production assets in both the SST and CAM regions.

The Company has followed a robust internal asset management process and has engaged with customers in detail on what elements of service are most valued. Engagement with the CCG has focussed on detailed elements and specific large projects within the plan which the Company has put forward.

The one off interventions and continuing work programmes and strategies put forward in this plan will ensure that water supplies continue to be resilient and meet the high quality standards expected by customers and set by regulators.

The bulk of this document has presented information on overall themes of work within the capital maintenance and quality expenditure categories for non-infrastructure assets, providing case studies for specific projects which contribute to these overall strategies and to the Company's outcomes. This final section of the document will now present a summary of the capital maintenance expenditure requirements which result from this plan and a comparison of these with AMP5.

The table below shows the expenditure in line with the themes used within this document, and compares the AMP5 forecast and AMP6 planned expenditure for the combined SSC water undertaker.

Theme	SSC AMP5	SSC AMP6	+/-
Maintaining groundwater pumping station reliability and quality compliance, borehole maintenance programme	£2m	£2.8m	+£0.8m
Maintaining groundwater pumping station reliability and quality compliance, civil refurbishments	£0.8m	£0.8m	£0
Maintaining groundwater pumping station reliability and quality compliance, mechanical and electrical refurbishment	£7.3m	£7.3m	£0
Dealing with nitrates at groundwater pumping stations	£7.6m	£9.1m	+£1.5m
Treatment gas independence (TGI) in the CAM region	£2.2m	£3m	+£0.8m
Maintaining surface water storage reservoirs	£0.1m	£0.5m	+£0.4m
Maintaining water treatment works reliability and quality compliance, civil refurbishments	£1.8m	£1.5m	-£0.3m
Maintaining water treatment works reliability and quality compliance, mechanical and electrical refurbishment	£7m	£6.1m	-£0.9m
Maintaining energy efficiency of pumping stations and installation of renewable energy plants	£2m	£3.1m	+£1.1m
Maintaining structural integrity and quality compliance of service reservoirs	£2.5m	£7.5m	+£5m
Maintaining booster pumping station reliability, mechanical and electrical refurbishment	£3m	£1.7m	-£1.3m
Total	**£36.3m**	**£43.4m**	**+£7.1m**

Whilst the water production non-infrastructure assets as a whole require uplifts in capital maintenance expenditure of around £7.1 million, it should be noted that this includes the quality compliance schemes for which the Company has sought DWI support. In total, the DWI have supported and intend to issue notices for approximately £2.3 million which is predominantly the nitrate plant at Fowlmere Pumping Station in the CAM region and the nitrate blending scheme at Churchill Pumping Station in the SST region. An additional £1.8 million for the Treatment Gas Independence (TGI) programme in the CAM region is driven by resilience needs under the Security and Emergency Measures Direction and is therefore also necessary. These obligations summate to £4.1 million of the £7.1 million increase. As can be seen from the table above, the Company has traded off expenditure requirements within the non-infrastructure assets (this commentary) to partially fund assets which require uplifts in expenditure. This has been done with full consideration and detailed analysis of the individual assets involved and the risks they present over the next 25 year period. The Company has also traded off expenditure requirements from other areas of the business to help fund these small but necessary uplifts.

As detailed in Section 3: The Asset Management Approach, the Company has undertaken a thorough cost benefit analysis and portfolio level optimisation of its AMP6 proposals across the business using its *Investment Optimisation* framework. This process has provided the Company with a means to derive the best whole life net present value from its proposed investment portfolio, working within both performance and cost constraints. The plans presented in this document represent the outcomes of the optimisation process.

Of the £43.4 million for Maintaining the Water Quality Compliance and Serviceability of Non-Infrastructure Assets, 81% is cost beneficial, excluding regulatory driven schemes and projects continuing from AMP5.

South Staffs Water

incorporating

CAMBRIDGE WATER COMPANY

Management and General

Business Case

December 2013

Executive Summary

The assets summarised within the Management and General Business Case are diverse, performing varied functions across the Company regions. These assets include the majority of short life technological assets comprising of; plant, equipment, IT and vehicles. Investment is necessary to maintain business capabilities and operational efficiency, allowing employees to perform their daily duties proficiently, providing continued high levels of customer service whilst achieving customers' expectations. The investment presented for AMP6 will ensure these levels of service can be capably maintained whilst aiming to deliver the Companies long term strategic outcomes.

Due to the managed deterioration of asset conditions over AMP4 and AMP5 and the predominantly short life of these assets, interventions have been identified to maintain the high serviceability levels and quality of service being achieved and experienced by customers. Numerous dynamic and vigorous assessments have been carried out across six sub asset divisions for Management and General, highlighting key investment for AMP6, ensuring that any investment put forward contributes to ensuring the Company continues to provide customers with fair bills and an excellent quality of service.

To establish a balanced customer focused business case for AMP6, the business has established multiple options for interventions across Management and General assets. For each scheme and asset category, four options were put forward where appropriate; Minimum, Essential, Optional and Premium. The options put forward, allowed the business to analyse investment against reductions or improvements in operational efficiency, performance and service to customers. Utilising the Investment Optimisation Tool, inclusive of Customer and Willingness to Pay Research, allowed a balanced, outcome focused investment programme to be proposed. Summarised below is the investment required in each category for AMP6 and the levels of investment put forward across the four options, highlighting the optimal selected level of intervention.

Information Technology 

Information Technology	Minimum	Essential	Optional	Premium
	£6.8m	£10.5m	£13m	£18.9m

The AMP6 requirements for both software and hardware remain similar to the level of investment undertaken in AMP5. Some of the systems which the Company continues to operate with, would become unsupported during AMP6, having an impact on operational efficiency and the experience and service customers receive. The Company has recognised by maintaining IT systems ensures operational activity is proficient, and the changes in customer expectations for service are met and current / future debt levels are managed.

Investing in the IT infrastructure will provide Company employees with an integrated information source, providing customers with a single point of interaction for first time contact resolution, delivering an excellent experience to customers.

Telemetry

Telemetry	Minimum	Essential	Optional	Premium
	£0.7m	£1.5m	-	-

Telemetry across the Company regions has been highlighted for replacement at the beginning of AMP6. This is required to negate foreseen system failures and operational inefficiencies, a consequence of which would ultimately see a need to introduce additional manpower to operate the distribution network. The current system operated by the Company will become unsupported in AMP6, with continued concerns in relation to system integrity, resilience and limited developments being made available. It is vital that the system remains stable, supportable and resilient to failure. There are significant issues associated with this at present due to unsupported product lines and evidently increasing hardware failure rates at remote sites.

Plant and Other Assets

Plant and other assets	Minimum	Essential	Optional	Premium
	£2.4m	£4m	£6.2m	£7.8m

Essentially 'Plant and Other Assets' are varied and largely impact upon either customers, functional competences, efficiencies and risks of non-compliance with regulatory and legislative obligations. Interventions identified throughout this sub set include (not limited to); leakage detection apparatus, vehicle diagnostic systems, water quality monitoring equipment and operational maintenance activity type tools such as floor saws, ground breakers etc. The replacement and maintenance of these asset types ensure the Company meets the expectations of customers, through safe and timely resolutions to operational activities, whilst minimising the impact on the environment.

Offices and Workshops

Offices and workshops	Minimum	Essential	Optional	Premium
	£1.6m	£2m	£2.8m	£4m

Investment in offices, workshops and buildings allows for Company sites to remain habitable and suitable for employees, members of the public and its operational assets. The Company sites contain a variety of buildings which vary in age from the late 1800's through to today. These buildings provide the necessary housing of employees and provide protection and security to the pumping and water treatment equipment and are therefore assets which need to be maintained effectively. The Company undertakes annual inspections of all of its buildings using an internal buildings management team and compiles reports detailing defects. Failing to intervene in this area would present the Company with unacceptable risks to the health, safety and welfare of employees and members of the public as well as not being able to meet legal obligations.

Security 

Security	Minimum	Essential	Optional	Premium
	£1.8m	£2.9m	£3.4m	£4.3m

The Company proposals for security interventions during AMP6 aim to ensure compliance with government advice notes and to ensure customers continue to receive secure, safe and reliable supplies of drinking water. The Company continues to assess sites and condition of security resources to make certain suitable mitigation measures remain effective. Without undertaking investment in maintaining security levels, the Company would not only be non-compliant with government advice notes, unacceptable risks would surface and increase the potential for contamination and third party interferences.

Vehicles 

Vehicles	Minimum	Essential	Optional	Premium
	£6m	£6.9m	£7.9m	£12.6m

The Company has a large fleet of vehicles which allows its employees to fulfil basic operational functions and meet legal obligations placed on the Company. The fleet strategy entering AMP5 functioned on a three year replacement policy for vans, during this period the strategy altered with the business accepting more risk going into AMP6, moving to a four year replacement policy. This decision allows for the fleet to be effectively managed out of manufacturer's warranty removing the need to replace vans after three years. The Company will effectively be replacing vans three times in a twelve year period rather than four, removing the purchase of one hundred and sixty five vans in this twelve year period. This decision does incur foreseen and unforeseen operational costs which the Company is willing to accept, whilst it may have a minor potential for impact on customer service levels, the strategy will significantly outweigh this by contributing to customers receiving fair bills.

Proposed Interventions

The Company proposes interventions in all areas of Management and General to sustain high levels of customer service, meeting expectations and continuing to maintain stable serviceability, addressing acknowledged unacceptable levels of risk. Two areas of significant investment are: Information Technology, which will ensure operational activity is efficient, changing customer expectations for service are met and debt levels are managed; and Vehicles, where technical engineering advances have resulted in an increased unit cost of each vehicle and where an economic risk review has impacted upon the replacement cycle.

Cost benefit analysis has been undertaken on 92% of the proposed AMP6 interventions and 88% of the proposed investment for AMP6 is positive. The remaining interventions that are valued as CBA negative have either been removed or where they have been included, they are important in providing current levels of

service or supported by Company policies. All levels of investment have been challenged by Executive Directors, and deemed necessary to effectively and efficiently operate business functions.

Balance of Risk and Affordability

The Company has proposed interventions based on the most cost effective options with limited risk being applied to customers. This business case aims to replace assets, only when the need arises, to ensure that the best value to customers is achieved rather than wholesale blanket replacements, providing an optimal level of intervention selected for AMP6. The analysis and assessment of forecasted deterioration to assets and the impact of non-investment will lead to:

- Reduction in quality of service being received by customers
- Non-compliance with regulatory and legislative obligations
- An increase on current areas of operational expenditure
- New additional operational expenditure not currently required
- Increased risk of serviceability to customers

Summary of Key Investment and Outcomes

Management and General	**AMP5 (Actual and Forecast)**	**AMP6 (Forecast)**
Investment	£28.4m	£26.7m
Overheads	£5.4m	£5.8m

Category (AMP6)	**SSC Spend (£)**
Information Technology	£10.5m
Telemetry	£1.5m
Plant and Other Assets	£4.0m
Offices and Workshops	£2.0m
Security	£1.8m
Vehicles	£6.9m
Total	**£26.7m**

- Investment in Information and Technology services (including Customer Resource Management) allows for systems to be developed towards a total system integration, maintaining reliability and resilience, in order for customers to continue to experience an efficient quality service
- The replacement scheme for SCADA is vital to ensure the Company can consistently monitor the performance of stations through a dependable system, to safeguard continued supplies of quality drinking water received by customers
- Maintenance and interventions identified for Company offices, workshops and buildings is essential to address and mitigate the evaluated risks to the health, safety and welfare of employees and members of the public
- The replacement of vehicles is fundamental to the Company continuing to operate an efficient, reliable service meeting customer expectations

Contents

1. Introduction

The Management & General sub-services encompass a vast range and majority of short life assets. These assets have been categorised as in previous AMP submissions. The investment put forward for AMP6 has been grouped with similar assets which have a comparable profile and investment drivers.

Management and General Classifications:

- Information Technology
- Telemetry
- Plant and Other Assets
- Offices and Workshops
- Security
- Vehicles

The cost effective planning objective has been applied to the Management and General investment category and has been supported by a cost benefit analysis methodology through the use of the Investment Optimisation (IO) Tool to ensure that the AMP6 Business Plan harvests affordable and fair customer bills.

The vast majority of business managers have assets which fall within the Management and General categories and the assets are situated across the Company geographical areas. Due to the relatively small size of the regions, business managers have close relationships with their assets, allowing assets to be optimally managed at local levels whilst utilising good asset management practices. This allows for managers to understand an assets' criticality, risk, impact, probability of failure and the implications when an asset fails on the wider business and customers. Interventions relating to Management and General assets have been included to maintain stable serviceability whilst aiming to ensure debt levels are managed, at the same time as continuing to effectively meet customer expectations and to continue to deliver high standards of service.

This business case outlines the total SSC spend for wholesale and retail investment as a combined total. The wholesale and retail breakdown of investment relating to Management and General asset categories can be seen above, with detailed commentary written in *Section A of the Final Business Plan – Wholesale and Retail Plans*.

2. The Asset Management Approach

The process leading to AMP6 investment under Management and General has engaged over twenty project managers including positions such as; Director of IT, Head of Customer Engagement, Head of Business Information Systems, Leakage and Network Maintenance Managers, Site Maintenance and Building Managers etc. The Company has followed a risk based asset management approach aligned with PAS-55, encompassing the Common Framework and the principles of Ofwat's previous AMA process.

The Company has furthermore utilised a wealth of experience in operating and maintaining Management and General asset types in identifying investment in this area. The Company employs competent and experienced personnel to utilise, maintain and assess the condition of these assets in order to optimally manage the operational and capital investment. The primary means by which the Company monitor the serviceability of these assets is through inspection and maintenance programmes outlined through good asset management practices. The Company, during AMP5 has continued to embark on working towards and embedding PAS55 asset management principles, implementing best practice asset management.

A review of proposals, delivery of projects including asset replacements for AMP5 has been completed to identify the Companies position moving closer to AMP6. Where projects have been accomplished, the lessons learnt from these have been captured and have influenced investment being proposed for the coming AMP. Previous expenditure and efficient delivery of outputs are demonstrable to improving the ever changing customer service and expectations. The Company has recognised that expectations of the Company have changed significantly during AMP5 and this outcome has seen the Company respond accordingly by continuing to invest in areas to ensure customers receive an exceptional service, maintaining secure supplies and fair bills.

Embracing these expectations has required the Company to ensure that all investment is subject to a structured and vigorous authorisation process. Internal and external challenge has been applied to all investment at different levels on justification, evidence and cost accuracy. External challenge has been undertaken by the Customer Challenge Group (CCG) utilising Monson for engineering expertise. Further detail on this can be found in *Section 4: Customer Engagement and Challenges*. Utilising area specific project managers has allowed individual justifications to be target challenged internally by Executive Directors and all investment has been subjected to a cost benefit analysis methodology using the IO Tool.

The Company Long Term Strategy (LTS) outcomes and future service delivery highlighted a need to review the investment portfolio for AMP6 accordingly to ensure the interventions meet the requirements being put forward. Investment for AMP6 across the six sub divisions for Management and General marry to the LTS and aim to embrace the challenges the Company face. Utilising the LTS and customer research undertaken for the AMP6, consultation has taken place when looking at the Management and General investment group. The review of Willingness to Pay and Customer Acceptability Research has indicated that customers are generally happy

with the current levels of service being achieved by SSC. This indication supports the investment put forward in this area to maintain current levels of spend, with planned improvements to how customers received information and interact with the Company.

The Company has utilised consultant support from Mott MacDonald for its overall asset management activity; and SGS UK Ltd to provide guidance for the Company's PAS-55 implementation, which is on-going. Both consultants have been utilised to provide guidance and support for the asset management activities carried out internally, not to provide asset management outsourcing. The Company is 'close to its assets' at all levels within the business and believes that this high level of internal ownership is key to achieving robust levels of service today and in the future, whilst retaining the ability to be flexible and efficient for continued low bills compared to the rest of the industry.

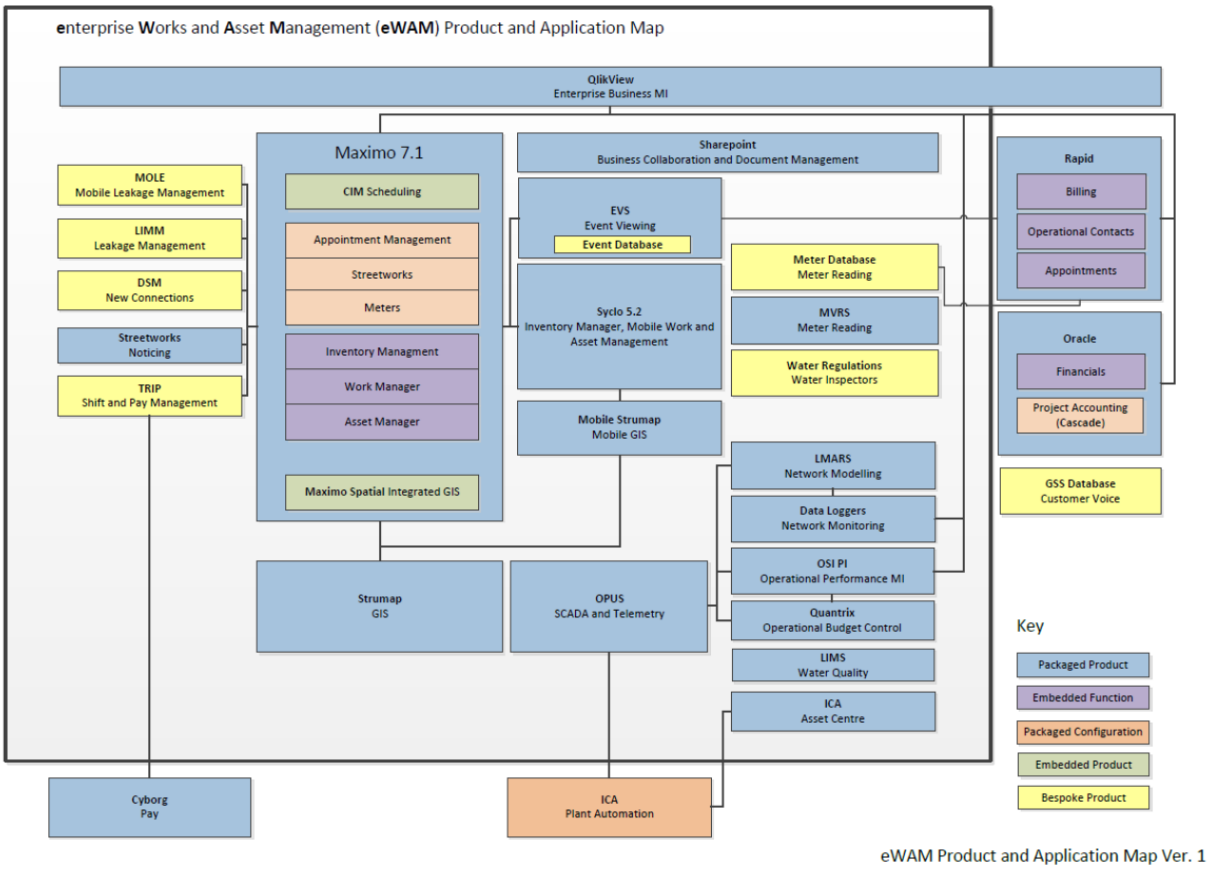
Further information on the high level asset management approach is documented in the *Asset Management Strategy.*

3. Asset Sub Group Commentaries

3.1 Information Technology

Information Technology (IT) assets are predominantly categorised as short life assets. The IT asset sub group is susceptible to influence from external technology markets, customer expectations and by direct business requirements. IT assets continue to become more and more critical to the majority of operations and functions, providing more diverse functionality to deliver operational efficiency and availability of information.

Business dependency on IT assets has increased and will continue to do so through the AMP6 period, making it fundamentally intolerable to operate without them and the investment required maintaining their integrity. Such dependency of IT can be found in areas such as: enterprise Works and Asset Management (eWAM) that enable the effective deployment of workforce and capture of information pertaining to asset performance; derived maintenance and optimisation; Customer Relationship Management (CRM) and billing systems are essential in managing customer needs and expectations; and many other systems that simply enable people to carry out their daily duties efficiently. Examples of diversity and dependency on IT assets exist in relation to information and documentation management, and also within business and regulatory reporting capabilities.



eWAM Product and Application Map Ver. 1

For the purposes of managing assets and analysing captured data, ensuring policies and asset management practices are appropriate to the specific types of equipment, assets in this group have been categorised as IT Software and IT Hardware. The Company asset register for IT Hardware was introduced in 2005 and continues to hold a comprehensive list of attributes against each asset, examples of which are listed below:

- Asset number
- Manufacturer / Model
- Specifications
- Serial Number
- Purchase date
- Allocated User
- Department / Location

Details of IT Software are collated from installed equipment to ensure all data is captured for licensing compliance. In all cases information is recorded and reconciled against purchasing records through Oracle. Examples of the information held are listed below:

- Software Name / Version
- Manufacturer
- Installations and Dates (linked by asset number in Hardware Asset Register)
- Number of licences held (Effective Licence Position)

All IT related requests and faults are logged via the IT Helpdesk against the asset or application ID and profiled accordingly to ensure that issues can be dealt with in a timely manner. The records capture all direct costs such as employee allocated time and materials and are fully auditable. Reports can be produced for each asset or group of assets and can be filtered by user, department and application. Reports are used to monitor operational working practices and highlight areas where excessive resources are being used, which then leads to more in depth investigations by Company IT personnel. Due to the Company's relatively low number of front-line support staff, any equipment, user or type of recurring fault can be identified and then records are used to confirm the information. This information is reviewed by the Company's IT Department on a regular basis and used to make informed management decisions regarding the required necessary interventions and investment. The system is audited externally on an annual basis to ensure governance and authorisation levels are appropriate.

For effective management of IT there are a number of policies which are applicable to the management of and investment in this asset group. Two Strategic Policy Statements (SPS) outline the manner in which this asset group is managed at a corporate level:

- SPS13 – Business Systems
- SPS15 – Technology Innovation

The policies above outline how business systems are selected based on industry best practice, proven software and product reliability. The Investment Policy Statement (IPS) outline how data is maintained, managed and ensures that the data is securely protected. Maintaining data integrity, data compliance and availability, is fundamental to the operation of this asset group and the continuation of operations. The IPS's below set out specific guidelines for investing in this area:

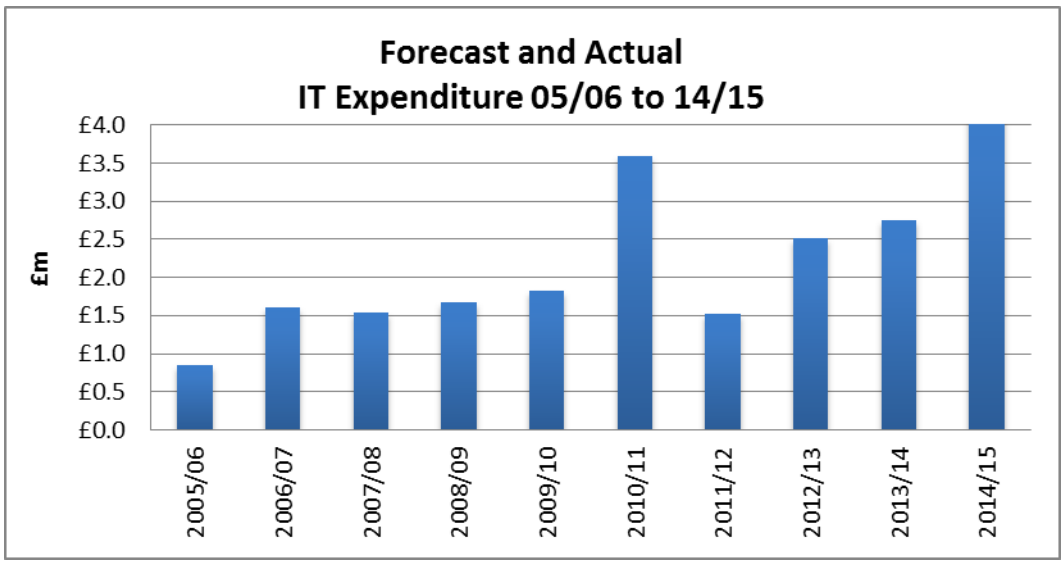
- IPS8 – Data Backup and Recovery
- IPS9 – Data Independence
- IPS13 – ICT (Information and Communication Technology) Replacement
- IPS14 – ICT Support & Maintenance

The Company Digital Strategy follows proven best practice, pursues innovative and proven technologies, implementing only where a benefit can be gained to keep pace with customer expectations. These expectations have become evident in the Focus Group and Willingness to Pay (WtP) work undertaken with customers. There is a growing use and preference for increased payment methods for utility bills and for the submission of information by the customer such as meter reads and changes to customer status. Customers expect to have alternative methods of contacting the Company, for example via the internet and mobile phone applications.

The business continually monitors and analyses the market place, observing trends in technology and learning from experiences of similar companies who deploy new technology, to identify where real opportunities for improvement exist. Although this may appear that the Company is more of a follower and less of an innovator, in reality, the Company is managing technology risk by not investing in new technology for investment sake.

3.1.1 Historical Service Delivery

The graph below shows historical and forecast expenditure in IT since AMP4 2005/06 to the end of AMP5.



Over the 10 year period displayed above, from 2005/06 to 2014/15 inclusive, the average annual capital expenditure in this asset sub group is £2.2m.

The peak in 2010/11 can be attributed to the implementation of a new best of breed enterprise Works and Asset Management system, Maximo, which replaced a legacy in-house developed system. Although the asset life for IT systems does vary, generally, system replacements or major upgrades are expected every seven to ten years with minor upgrades every two to three years, covering system changes and developments. The decision to replace or upgrade is taken based on supportability, functionality and cost. The IT market now provides the Company with a greater choice of industry standard products where interconnectivity with other systems is customary. Whilst the benefit of such interconnectivity is obvious, such capability is generally associated with market leading products.

3.1.2 Delivering Future Service

Service and Cost Forecasting

Key drivers for investment are:

- Preserving and enhancing customer choice and service
- Continued quality of service being received by all stakeholders
- Improved effectiveness and efficiency of business operations
- Enhanced business reporting and information management
- Sustained system operation and supportability

The Company has undertaken work to evaluate a number of options and concluded with a prioritised list of 'high' level strategic outcomes focused around maintaining operational efficiency and meeting future customer service levels and expectations. These outcomes were consistent and confirmed a number of recognised business needs identified in the Digital Strategy and enterprise Works and Asset Management investment justification.

This comprehensive review identified that the business would benefit through the rationalisation and improvement of the Company's asset related IT systems by adopting integrated 'packaged' solutions. Further benefits will be delivered by improving information management and reporting capabilities to provide accurate and up to date information. Further developments will maintain customer services levels and allow adaptation take place to meet changing customer expectations.

The key needs identified included:

- Providing customers with consistently high quality service levels through the maintenance and developments of the Customer Relationship Management systems providing channels of choice
- Stabilise and reduce customer debt levels
- Improved information management and reporting

The business depends heavily upon its IT systems and software applications to facilitate everyday operations and maintain the levels of service its customers demand. Drivers this AMP period are not dissimilar to AMP5 in that it will be essential to:

- Maintain customer service levels
- Meet future customer expectations
- Sustain and optimise operational efficiency

At the outset of AMP5, very little integration was in place which presented a challenge to achieving the above. However a highly successful programme which centred around the implementation of an enterprise Works and Asset Management solution significantly changed the IT landscape by introducing high degrees of integration between systems and functions. This in itself has created problems particularly around system dependencies and data quality. It is essential moving into AMP6 that the data quality issues are resolved and system dependencies are protected. However, with an integrated solution now in place, the business has a solid platform built on best practice and best in breed packages to build upon in AMP6 to ensure operational and customer experience levels of excellence are preserved.

Prior to AMP5, the business relied heavily on the development of bespoke 'in-house' applications to satisfy functional needs. This was particularly so around two core work and asset management solutions, namely Ami and WaterXP. Part of the undertaking to deliver an enterprise level solution for Work and Asset Management adopted a significantly different strategy which utilised best in breed packaged solutions where available. Whilst this has in some instances compromised achieving a 'perfect product' for the Company, this approach has delivered a significant level of capability in a relatively short time and in many cases the business has acquired 'best in breed' capability by default. It is proposed to carry on with this approach in AMP6 only utilising bespoke developments where packaged solutions are not available or are assessed as not suitable. Projects including system upgrades will be procured either through framework contracts or competitive tender as appropriate.

In terms of in-house skills and knowledge, the business is well positioned to expand and enhance many of the systems internally, subject to purchasing or upgrading a number of off-the-shelf software tools or licences. Indeed, this ability will play a key role in enabling the business to integrate operational data with business systems like the works and asset management systems to improve operational efficiency and produce accurate asset costs as an example.

Whilst to date AMP5 has been largely successful in building a new software platform for the future, there remains a significant challenge in AMP6 to maintain and enhance each system with the continued drive to achieve operational efficiency and to deliver an excellent customer experience. It is therefore essential to:

- Ensure systems are; economically sustainable, supported, resilient, reliable and continue to build on current standards that facilitate supporting growth, enhancements and regulatory changes;

- Ensure business performance is enhanced through system integration so timely and accurate operational and customer orientated information is available contributing to informed decisions for an excellent customer experience.

This will be achieved in AMP6 by:

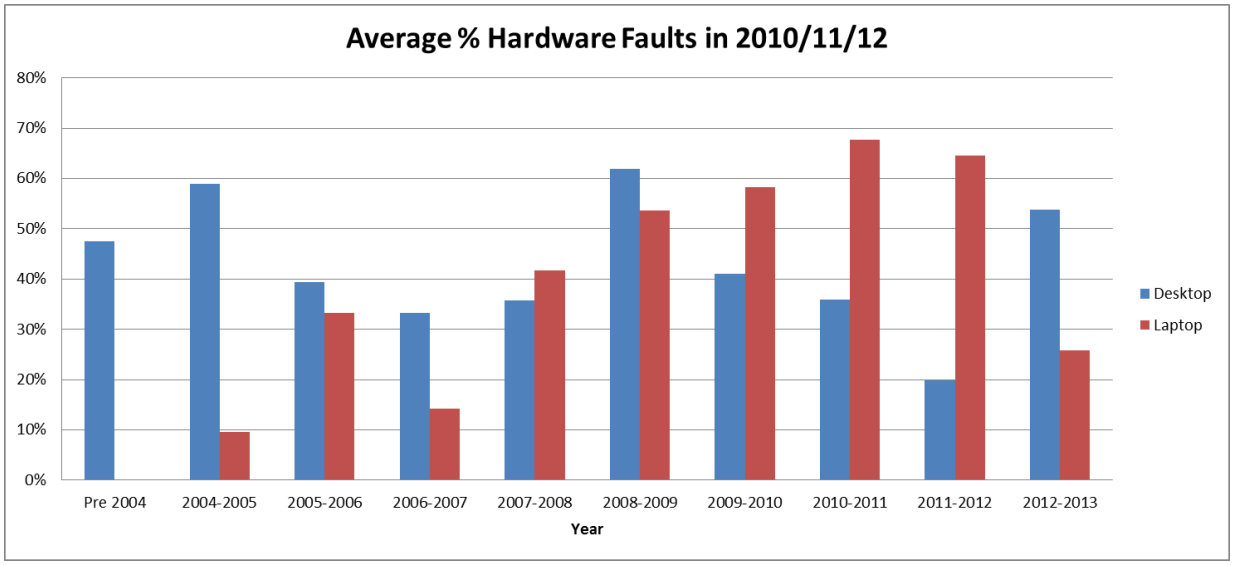
- Building on the integrated; Work, Asset, Billing, Contacts and Financial platforms deployed during AMP5 with targeted investment around timely system enhancements and product updates to ensure continued serviceability of the entire software enterprise.
- Retire and replace any unsupported systems or systems where support is expected to expire.
- Integrate Work and Asset Management, GIS and CRM for enhanced customer service and operational effectiveness
- The continued use and application of packaged solutions as opposed to bespoke developments where off-the-shelf products based in industry best practice are available and deemed suitable.

It is vital the hardware that underpins software applications, both minor and major, essential to business operations is adequately maintained. Although there will be an increased need for data storage and technology investment to satisfy the increased software needs described above, investment will remain stable, offset by a general reduction in the price of equipment.

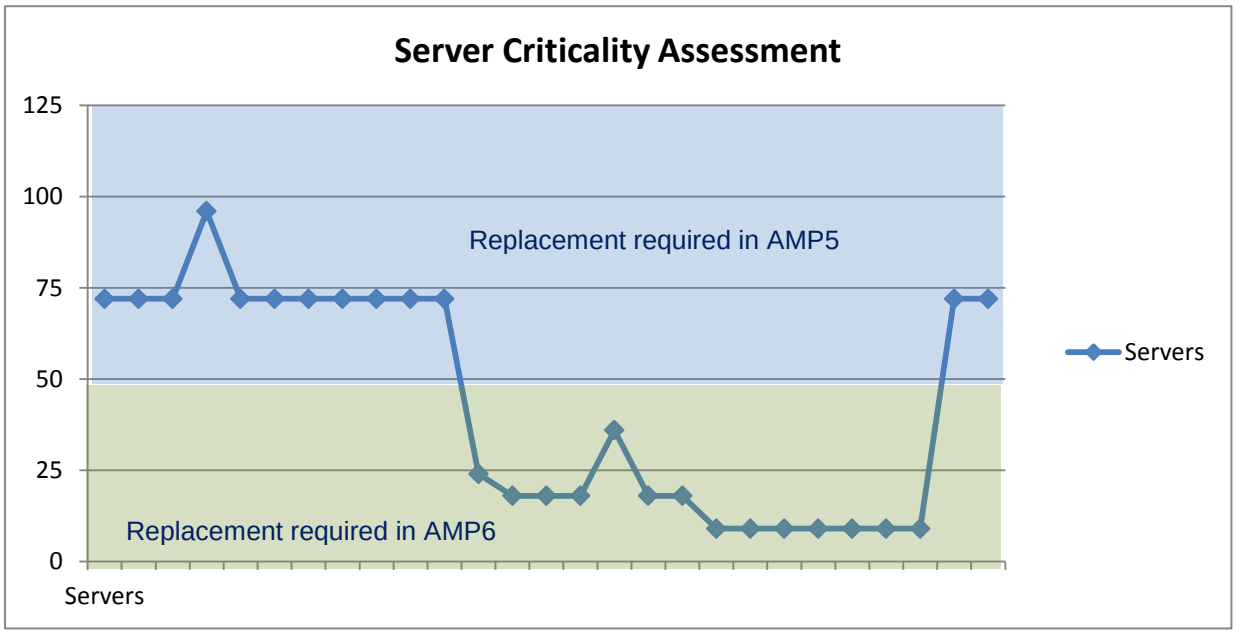
Investment needs have therefore been determined around:

- A continuation of business as usual
- To maintain current business capabilities
- Support additional software requirements
- Support continued developments too and meet the levels of customer service required

The graph below shows average percentage of hardware faults from 2010 to 2012 across ‘Desktop’ and ‘Laptop’ devices based on their installation dates. The data collected shows that hardware reliability is not necessarily affected by age. Certainly most calls taken from the user base are received when new systems are implemented; suggesting more training may be required. Software authors and hardware manufacturers only support and maintain systems up to a certain age. The Company replacement strategy is not based on age, but on the basis that the software is fit for purpose and the ability of hardware to support it.



The graph below is another example of how the Company assesses intervention requirements through a risk assessment profile carried out for criticality of IT 'servers':



The assessment is based upon the following factors:

- Redundancy and reliability,
- Failure likelihood and duration,
- Effect of failure on numbers of employees and whether their roles were customer facing,
- Effect of failure on operating and capital expenditure. Customer facing/ non customer facing, single user / multiple users, and
- Regulatory impact in the event of failure

Each category was given a scoring range based upon known and identified risks. The optimum score identified to replace assets in this category was 50. This is the

point at which risk of failure, based on the factors above, is unacceptable to the Company.

The Company have, during AMP5, virtualised the majority of servers in line with industry guidelines. This reduces costs by decreasing management overheads, making more efficient use of the hardware available and also reduces energy costs. Each physical server, though, is more critical to the operation and provides a higher number of services per host, increasing the requirements for reliability and resilience. The graph above shows the scores for the criticality assessment undertaken for each physical server in the Company based upon the criteria enlisted above. The shading shows those servers to be replaced within the existing AMP period and those requiring replacement in AMP6. Some servers will need to be replaced prior to this assessment scoring due to removal of support by software vendors on their products where enhancements, modifications or upgrades are required to ensure that the technology is in line with business requirements.

The current infrastructure must remain stable and reliable on two counts:

- To provide the platform enabling all current systems to continue to operate as required.

- To provide the flexibility to ensure that any modifications or enhancements can be integrated seamlessly and in as short a time as possible to ensure the highest return on benefit for the business.

Technology is continually evolving and the Company must continue to keep up to date with systems to ensure their security, integrity and ability to change when required. Vendors generally operate to a 3 to 7 year lifecycle for hardware and software; therefore, a large proportion will become obsolete or unsupported during the AMP6 period.

The hardware infrastructure underpins many of the processes and working practices essential to Company operations. Over 20% of the hardware infrastructure is expected to become unfit for purpose in AMP6 and an additional 50% will move above the Company's acceptable threshold of risk based on supplier data of available support. A failure to intervene here will ultimately lead to systems failing, the impact of which being a serious and potentially irreversible impact. Data storage, for example, is critical for information management, as is IT security and preventing unauthorised access to protected information. Further examples of failure that must be avoided are the hardware and software platforms upon which key business applications, such as asset and work management and the financial systems reside and in the area of telecommunications.

Failure to invest in this asset group will have an effect on internal and external stakeholders. It will result in operating inefficiencies with the need to return to increased staffing levels, inconsistent unreliable data and an impact on quality of service to customers with the potential to affect SIM and efficiency scores. The Company's reputation for high quality customer service will be damaged, which will have an adverse effect on regulatory confidence. There will be a reduction in staff productivity with recording and analysis of data having to be carried out manually,

inaccurate and inconsistent data will have a detrimental effect on the Company especially where there are regulatory, legislative and financial reporting requirements. There will be increased fines for non-compliance of legislation such as the new Traffic Management Act, detrimental effect on the speed of responses to customers, the accuracy of data being supplied and ultimately there will be an effect on customer levels of service.

Planned Intervention Analysis

In identifying the investment required for AMP6, options have been considered as described below.

The Company recognises that they could continue in the very short term without any developments or maintenance of its software systems, however, this would expose risks and introduce significant compromise to efficiencies and the service afforded to its customers. Firstly, risks would be exposed by a lack of system maintenance and potential security issues with system integrity, quickly becoming unstable due to a lack of patching or system updates. Secondly, the business would lose the opportunity to improve on operational efficiency and/or keep pace with customer expectations around the levels of service they receive. Combined with the ever increasing and changing demands placed on the business to provide more information regarding its activities and with a rapidly changing technology landscape, failure to invest would ultimately lead to the business being unable to operate effectively. This, therefore, is not a realistic option.

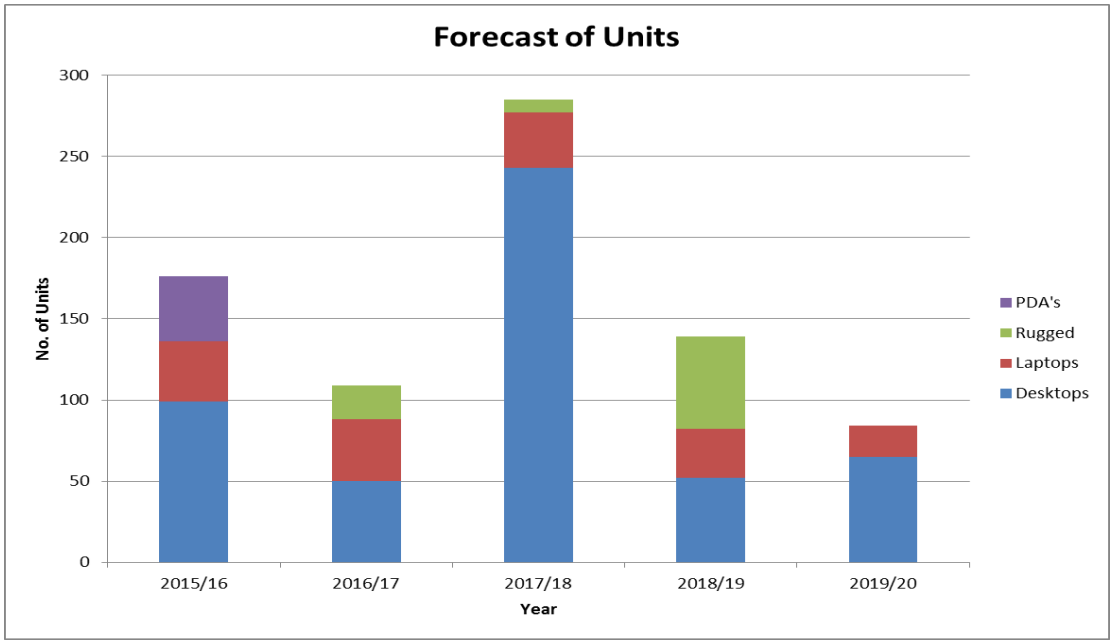
Systems that have become difficult to support due to either the skills required or the age of the technologies involved, will be programmed for replacement in AMP6 as they were in AMP5. As discussed previously, AMP5 witnessed a shift away from in-house development to the procurement of packaged solutions and this strategy would be adopted again. Only in instances where this is not possible or suitable will in-house solutions be considered. As with AMP5, this approach continues to offer the following advantages:

- Faster deployment and return on investment
- Industry standard approaches and system interoperability
- Reduced business risk due to wider support networks (skills) available

The Company has a reputation for excellence by working with all stakeholders and the investment shows a commitment to maintaining a high level of service delivery. Interventions are required for the development of service solutions driven by customer expectations and influenced by the wider levels of service, technological advances provided by the other utilities and the broader service sector. These expectations continually expand and become more technologically complex to satisfy customer needs. Customers will, for example, expect greater ease of interaction with the Company through the use of mobile phones and the internet. Solutions will be developed to provide customers with an increased choice, such as on-line web and text messaging for bill payment, increased options for providing meter readings, for example Interactive Voice Response (IVR) and web meter reading facilities. The increase in investment is necessary to maintain the Company's positive customer experience and good levels of service.

Failing to invest here would impact on the service the Company could provide to its customers. It is known that customers will increasingly expect direct access to their accounts, be able to view meter readings, have a faster response time to queries. In general, they will be demanding a faster, more direct, simpler but comprehensive interaction with the Company. In order to make information available in a timely and effective manner such that it can be used to make 'real' and 'effective' decisions both operationally and for the purpose of customer service, investment is required to consolidate data from multiple locations and present it in a usable format appropriate to the end user. Therefore appropriate solutions will be provided for the senior executive managing overall Company performance to the field operative managing the customer interface.

Hardware will be maintained in line with AMP5 expenditure levels which are sufficient going forward to support the programmed software upgrades and replacements in AMP6. The forecast for replacement of hardware assets is shown below.



Interventions are required in the IT infrastructure, including the upgrade and replacement of hardware. The emphasis is to ensure that risk is minimised, implementation of new systems and modifications are delivered in line with the expectations to gain the maximum benefit, and where possible identifying opportunities to assist the business in reducing its carbon footprint.

With IT now a critical component at the core of everyday business operations, if systems are not maintained or developed, then the risk of failure affects the ability of the business to operate effectively. Dependency on IT systems is critical to the business operations. Examples of this are the complex communication and infrastructure networks that carry information between systems, departments and businesses. If these are allowed to fail because of a lack of investment, then the business would be incapable of operating without changing its processes and increasing staff numbers significantly.

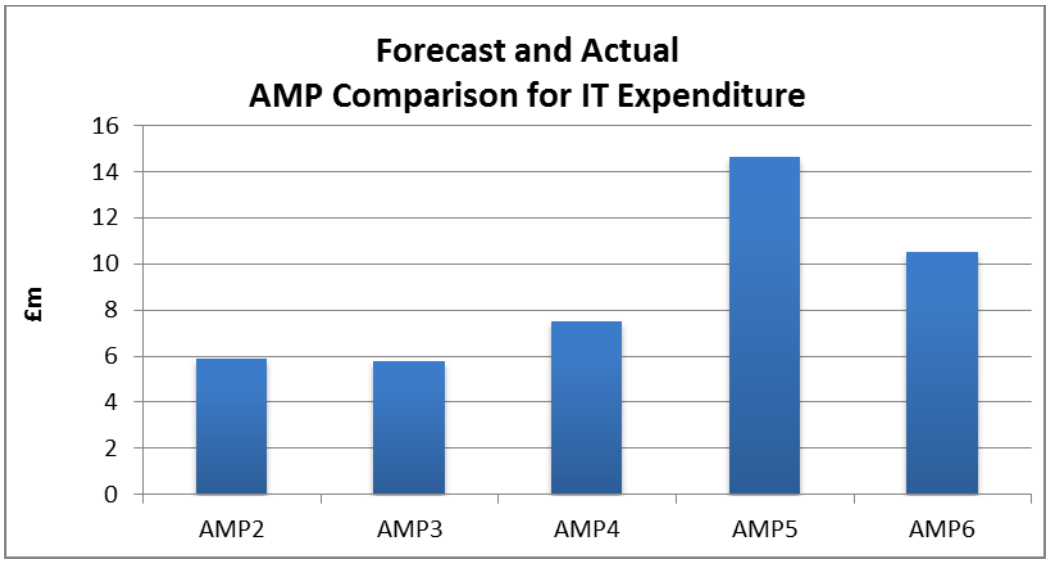
IT Hardware provides the underlying IT infrastructure for all the Company technological services. All of the software applications, major and minor, require a high degree of hardware reliability. Hardware failures will impact significantly on business capabilities and functionality. Stability and security are the key requirements of the hardware infrastructure and the theme is, therefore, ensuring that risk is reduced by keeping these items within manufacturer recommended support levels.

The proposed AMP6 interventions are deemed to be appropriate to balance risks to service with expenditure, since it is proposed to maintain existing systems where possible but replace inadequate and difficult to support systems with 'packaged' solutions where standard software solutions already exist. Any systems enhancements associated with maintenance will be incidental.

3.1.3 Conclusion

An investment of £10.5m (gross pre efficiency) is required for AMP6 (39% of the Management & General spend). This is a reduction in investment on the AMP5 forecast and actual investment of £14.6m.

The graph below shows historical expenditure in IT since AMP2.



Investment in IT software has been included to maintain customer choice and service, safeguarding a continued quality of service provided to customers, allowing the Company the ability to minimise operating costs, provide improved reporting and information management and continued systems operation and supportability.

Investment in IT hardware has remained consistent with that in AMP5 and is to ensure that infrastructure remain supportable and reliable, and capable to deliver software requirements. Failure to invest in this area will result in deterioration in levels of service, inaccuracies in reporting regulatory and legislative requirements, increased operating costs and the inability to manage business operations effectively.

3.2 Telemetry

The asset components of the telemetry system are the central computer systems located at two regional head offices, the remote outstations that provide monitoring and control over operational sites, and the telecommunications networks that link them together. Collectively they manage over 200 unmanned operational sites distributed over a 1000 square mile area, providing alarm reporting, collection of operational and regulatory data, and remote control of key water production and network assets.

The Company's telemetry system is divided into South Staffs (SST) and Cambridge (CAM) regional areas. The SST system was originally installed in the early 1990s and has been upgraded periodically over previous investment periods with the objective of maintaining stable serviceability, thereby avoiding the more costly option of a full system replacement. Continuation of this policy into AMP6 is unfeasible as the system supplier is unlikely to be in a position to provide and support a long term solution beyond 2020, negating any investment made.

The CAM regional telemetry system is largely unchanged since its original 2000 install date and as such utilises an obsolete product line with restricted levels of spares and engineering support. Risk is therefore managed with a limited number of salvaged spares which cannot be replaced by the vendors.

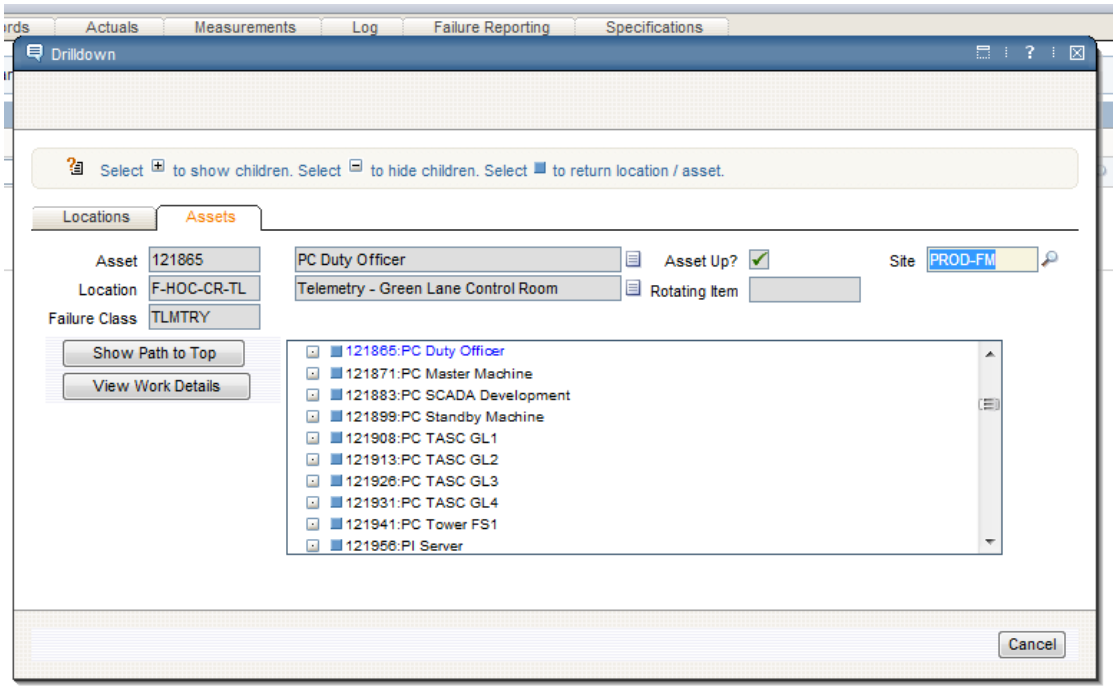
This asset class is fundamental to customer service. Without intervention there is a high risk that operational alarms will be overlooked and service failures will increase. In addition to this, vital performance data will not be recorded for regulatory reporting.

Replacement of both regional telemetry systems is required to ensure future system stability, supportability and reliability. In addition to resolving serviceability issues, replacement also provides an opportunity to consolidate the telemetry supplier base, enhance the Company's work scheduling and workforce mobilisation capability, incorporate additional remote asset data from distribution networks, and consolidate the control room functions leading to standardised working procedures and operating efficiencies.

The Company's Maximo works and asset management system holds details of major telemetry assets. Assets within this group can be broken down into the following categories:

- SCADA – Supervisory Control and Data Acquisition
- RTU – Remote Termination Unit
- Communications – VPN and radio links between sites and control offices

An example of a typical telemetry asset hierarchy is shown below:



The asset register is used to hold specific details relating to asset attributes for example:

- Type
- Part number
- Supplier

The work history against an asset or asset group is collected and held in Maximo and used to evaluate asset performance. Data on planned and reactive maintenance man-hours is recorded on the system. Internal audits on the quality of the data are carried out on a regular basis to monitor and report on data accuracy for management action. This ensures that decisions regarding asset performance are based on accurate and reliable data.

Labour costs are currently recorded for work carried out on telemetry assets. With the introduction of Maximo there is the ability to capture information on parts, materials and contract labour in the future.

The Company has two Strategic Policy Statements that outline the manner in which this asset group is managed at a corporate level:

- SPS13 – Business Systems
- SPS15 – Technology Innovation

The Company adopts systems that follow ‘best practice’ and proven business software. When using innovative technology, the Company ensures that software and equipment is resilient, reliable and cost effective.

Investment Policy Statements which set out specific guidelines for investing in this area include:

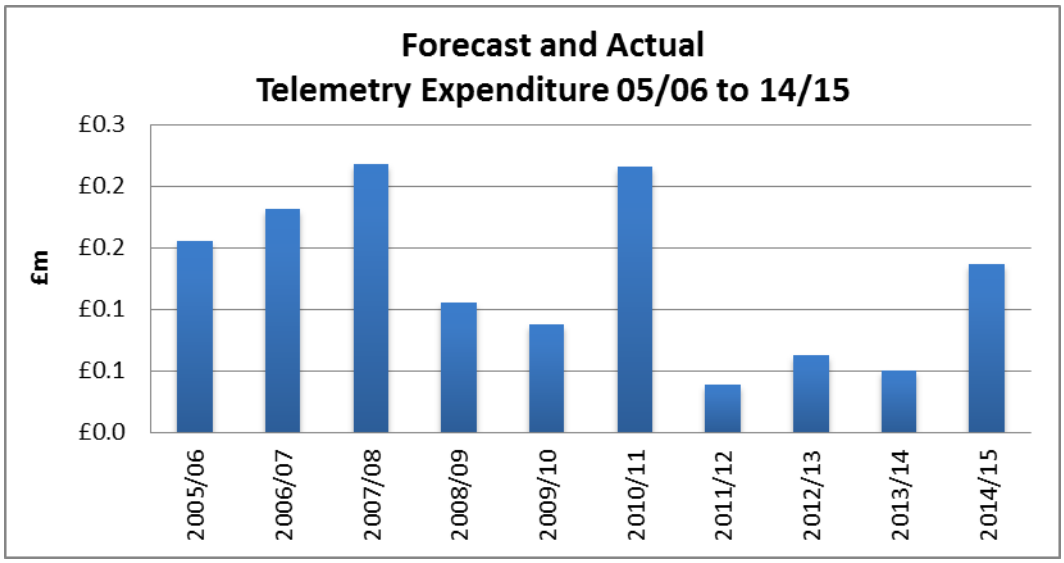
- IPS8 – Data Backup and Recovery Policy
- IPS9 – Data Independence Policy
- IPS12 – ICA Equipment Replacement and Maintenance
- IPS13 – IT Replacement
- IPS14 – IT Support and Maintenance

These policies detail requirements on the maintenance, high level operation and availability of the assets, ensuring that the integrity, reliability and security of systems are maintained at all times. The Company produced a Strategic Review Paper in 2013 for the Telemetry System that recommended interventions in AMP6 to replace the existing system with some minor additional developments to enable integration with other information technologies such as Maximo Works and Asset Management and GIS. An option to retain the existing Telemetry System was considered but rejected due to product obsolescence and support issues associated with the SST regional supplier's commercial position going into AMP6.

The Review Paper sets the strategy for AMP6 in the same way as the Strategic Review Paper for 2008 summarised the strategy for AMP5.

3.2.1 Historical Service Delivery

The graph below shows historical and forecast expenditure in Telemetry since AMP4 2005/06 to the end of AMP5.



Over the 10 year period displayed above from 2005/06 to 2014/15 inclusive, the Company has an average annual capital expenditure on this asset sub group of £0.13m.

The peaks in 2007 and 2011 were for upgrades of the IT system to ensure continued supplier support, system reliability and stability. Expenditure levels over this 10 year period are consistent with the Company's policy of maintaining stable serviceability through a series of software updates and hardware replacements, thereby avoiding the more costly option of a full system replacement.

3.2.2 Delivering Future Service

Service and Cost Forecasting

The asset subclasses within the telemetry asset group are detailed below. Contingency plans have been developed to manage all identified risks prior to delivery of any AMP6 replacement.

OPUS SCADA

This system is used in the SST regional control office and is supplied by a sole trader (Opus) who is responsible for original product development back in the early 1990s and all subsequent upgrades since then. The system has a very small client base, cannot be supported by external systems integrators and is only understood by two engineers within the Company. It utilises a number of none standard technologies that severely restrict compatibility with other information technologies and does not have the requisite levels of security and configurability required in a modern system. The current supplier is unlikely to be in a position to provide and support a long term solution beyond 2020, negating any investment made in AMP6. It is therefore the Company's intention to replace the system.

OPUS RTU

This product is used at operational sites throughout the SST region and is provided by the same sole trader that supplies the regional control office SCADA. The same issues therefore apply to this asset subclass and a replacement will be required to enable compatibility with a new top-end system.

Boward SCADA

This system used in the CAM regional office was installed in 2000 and inherited by the Company following its merger with Cambridge Water. The supplier no longer exists and only limited support is available from a single engineer who is accessed via a third party systems integrator. Its limited functionality means that it cannot meet the telemetry requirements for operational service monitoring and control. The Company therefore plans to replace the system in AMP6 and in doing so leverage operating efficiencies from moving onto a single supplier base and consolidating the SST and CAM control room function into a single office.

Logica RTU

This product is used at operational sites throughout the CAM region, is no longer supported by the manufacturer and cannot be upgraded as it is based on obsolete technology. Only a limited number of spares exist and a phased replacement will

enable replaced units to be salvaged to maintain the remaining units while they await replacement.

VPN Communications

The SST VPN telemetry network will be extended into the CAM region under an existing AMP5 provision as part of security work at remote production sites in that region. Routers that provide a gateway into the Company's managed IP based VPN telemetry network are due to be replaced under an existing AMP5 provision and associated costs are therefore also excluded from the business plan.

Future forecasts are based on the retention of the SST regional approach of using standard commercially available PC hardware in both the central SCADA and remote RTU devices. This minimises the risk of obsolescence when bespoke hardware ceases to be supported by a supplier, which can result in unnecessary and costly upgrades to maintain serviceability. This approach also enables longer term benefits in the form of increased functionality, higher processing speeds and greater flexibility for security and communication options.

Risk assessments are regularly performed on the Company's telemetry system. These cover the system's ability to effectively adapt to sudden changes in the operating environment and the associated cost of failure. The balance of risk against cost is then used to implement disaster recovery measures that are appropriate for the given information technology. Retention of the Company's existing system would see a continuing deterioration in outstation availability and an increased likelihood of a catastrophic system failure if a regional control office SCADA was to fail.

Examples of the impact of failure include being unable to:

- Manage reservoir storage levels effectively, ultimately leading to a loss of supply and or pressure at customers tap.
- React to fluctuations in supply demand in a timely manner to avoid customer supply issues.
- Monitor and react to alarms associated with chemical incidents either dosing related, through spillage, overflow or similar.
- Monitor and react to critical alarms associated with Reservoir access and security (threat of contamination).

These impacts will result in:

- Adverse impacts to customers and/or the environment.
- Increased risks of regulatory enforcement actions.

Planned Intervention Analysis

Given the importance of the telemetry system, interventions will be required in the following area:

It is vital that the system remains stable, supportable and resilient to failure. There are significant issues associated with this at present due to unsupported product lines, increasing hardware failure rates at remote sites, and the expected commercial position of the SST telemetry system supplier at the end of AMP6.

In addition to resolving the above system support and serviceability issues, replacement also provides the following opportunities to the Company:

Telemetry system integration

- SST and CAM regional telemetry systems will be migrated onto a common platform, with ensuing high levels of product integration being used to improve the sharing of operational data and enhance staff productivity through consolidation of the central control room function.
- Integration of SST and CAM regional telemetry systems will enable off-site disaster recovery to a secure location. This is limited at present due to non-compatibility issues and technical restrictions associated with existing system functionality.

Integration with other information technologies

- The telemetry system will need to automatically generate Maximo works orders from its alarm log, directly alerting the right engineer with the right information at the right time, without any manual data entry overhead or response delays.
- At present, the Supply and Network Directorates use substantially different information technologies which have been developed in isolation of each other. Data from both sources will need to be combined to provide a holistic view of operational data
- The GIS enables information from a range of disparate sources to be brought together into a single unified geospatial view, allowing the system to take pre-emptive action and problem clusters to be identified. The integration of telemetry data will enhance GIS capability by overlaying additional production and network data onto the map which is currently unavailable.

In identifying the investment required for AMP6, the following options have been considered:

1. ‘Do nothing’ and remain with the existing telemetry system. (Reactive)
2. Upgrade software and hardware and maintain the existing system. (Minimum)
3. Replace the telemetry system. (Essential)

1. ‘Do nothing’ and remain with the existing telemetry system.

This will result in increased levels of failure across both regional areas and an increased risk of total system failure in the CAM area, which is unacceptable for the Company. The longer the duration of any system failure, the higher the likelihood of impacts would be on supply serviceability indicators, i.e. DG2, DG3 and water quality. Furthermore, without intervention none of the opportunities detailed above will be possible.

2. Upgrade software and hardware and maintain the existing system.

This option is not feasible in the CAM region, as the system has been out of support for some time and therefore the opportunity to upgrade software does not exist. Updating the hardware would also prove problematic since the legacy operating system that underpins the system is no longer supported by Microsoft.

This option is also not feasible for the SST region as the current supplier is unlikely to be in a position to provide and support a long term solution beyond 2020, negating any investment made in AMP6. Furthermore, nearly all required interventions detailed above will not be achieved if the investment is restricted to an upgrade only as the functionality required is not readily available within the product.

3. Replace the telemetry system.

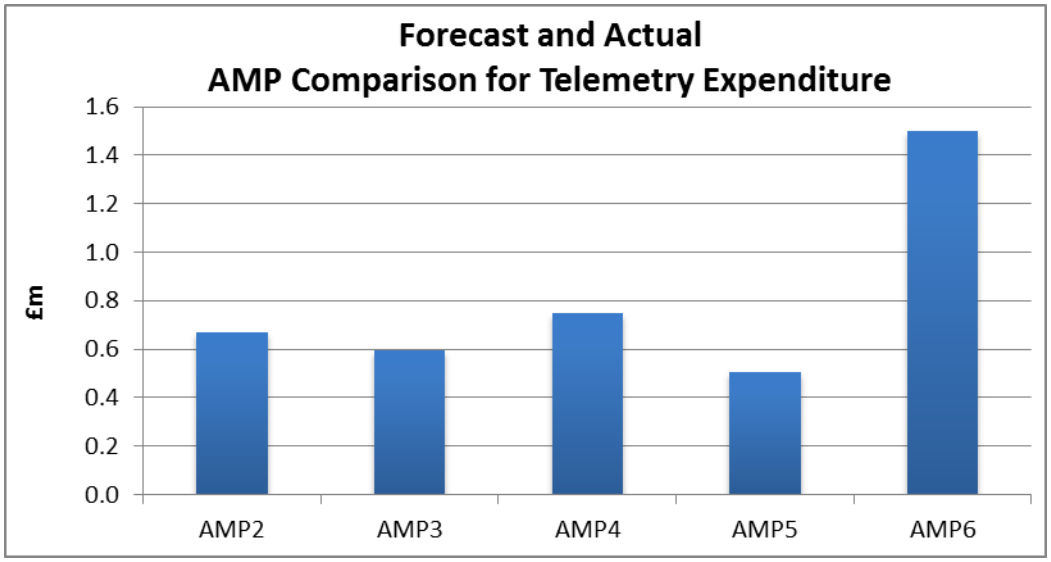
This option is for a total replacement of the telemetry system with an alternative product. This will significantly reduce failure levels, bring hardware and software back into support, consolidate supply and network data into a single database, enable data to be consumed by other information technologies such as Maximo and GIS, and enable the realisation of operating efficiencies achieved through control room consolidation. The requirement for a total system replacement was previously identified within the South Staffordshire and Cambridge Water AMP5 Business Plan and is consistent with the Company's long term roadmap for this asset sub-group.

All projects in this asset sub group are cost beneficial. Whilst carrying out the CBA workshop for telemetry equipment it was evident that failure to make this investment could result in an impact on a number of, if not all, of the Company outcomes.

3.2.3 Conclusion

An investment in the Company's telemetry system of £1.5m is required for AMP6 (6% of the Management & General spend). This represents an increase of £1m from AMP5 actual and forecast capital expenditure of £0.5m, due to the obsolescence of systems and issues with supplier position going into AMP6.

The graph below shows historical expenditure in Telemetry since AMP2.



The Company's team of experienced system engineers routinely specify, configure and commission SCADA and telemetry systems for both internal clients and as part of the unregulated business. As such, they are familiar with both the technical challenges and costs associated with this type and scale of project. This has enabled them to work with a leading water sector telemetry supplier to establish a firm initial costing that is representative of the general market place.

3.3 Plant and Other Assets

The plant and other assets sub group contain a wide range of assets required by the Company to fulfil its operational commitments and legal obligations. This asset group includes but is not limited to:

- Leakage detection equipment,
- Water quality monitoring equipment,
- Plant and equipment used to repair and reinstate bursts and leaks
- Network management equipment e.g. pressure monitoring equipment, active leakage control equipment and hydraulic modelling software
- Emergency water supply equipment e.g. bowsers and static tanks for emergency supply
- Fleet maintenance equipment associated with maintaining the Company's vehicle fleet
- Ancillary equipment e.g. plant and equipment associated with site maintenance, office furniture and staff training aids

Assets within this category cover a diverse array of functions and departments. The Company has a number of asset registers held in systems such as Maximo, Fleetplan and excel spread sheets or access databases, the majority of which are held locally by the Business Unit Managers. Each register has been amended to ensure that they hold consistent and appropriate attributes for each asset as documented in WRc Asset Tuning CP182.

Data on the number of faults and the numbers of repairs carried out on each of these assets is collected locally. The Company, during AMP5, has made progress in unifying all of the asset registers and works management system into Maximo. These assets are specialist tools and when faults occur many are sent away to be repaired or are simply replaced when items are beyond economical repair. Therefore, data on labour hours is not recorded. Cost data for assets is recorded on the Company's financial system, Oracle. Any repairs carried out by external companies are invoiced and the cost is recorded in the Company procurement system, IProcurement, which is then interfaced into the Oracle system and fed back to each of the budget holders. Cost data can also be recorded against an asset in the works management system.

For effective management of the assets in this category there are a number of policies which are applicable to investment in and running of this asset group:

- SPS4 – Health, Safety and Welfare
- SPS10 – Repair and Maintenance of Distribution System
- SPS12 – Supply Pipe Repair
- SPS16 – Asset Management
- SPS18 – Leakage Management

The Health, Safety and Welfare Strategic Policy Statement covers all areas of the Company as it is important that employees have access to equipment that is fit for

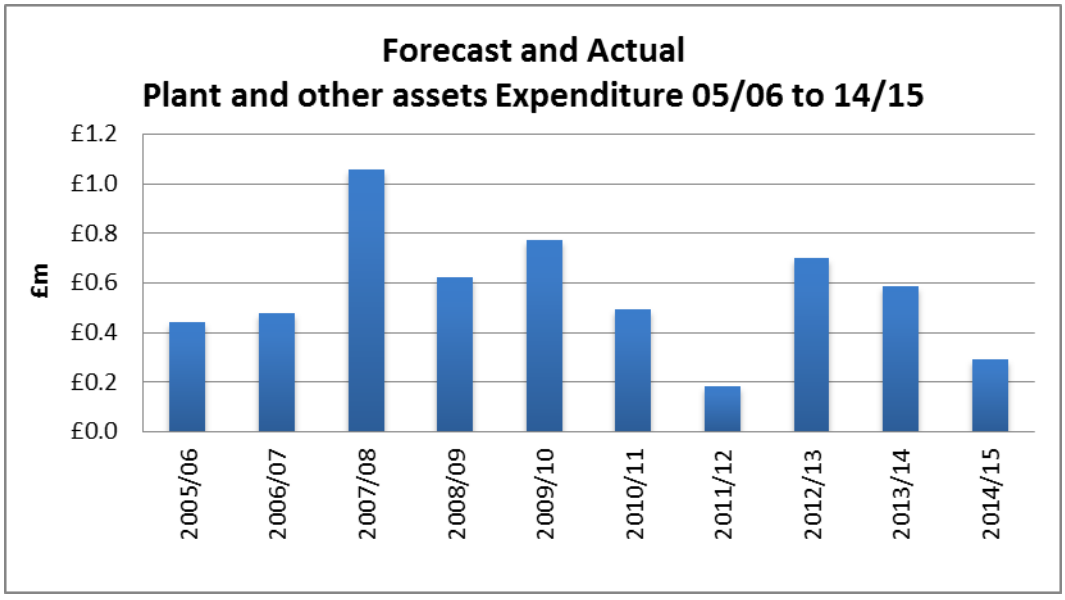
purpose and in a condition that does not pose a risk to their safety or that of the public. The Asset Management Strategic Policy Statement outlines the intention to manage assets and asset management practices systematically in order to achieve business objectives and statutory and regulatory obligations.

- IPS2 – Water Quality Laboratory Equipment
- IPS4 – Building Replacement & Maintenance
- IPS11 – Equipment Replacement & Maintenance

These policies are an integral part of the management of this asset group. The Equipment Replacement and Maintenance Investment Policy Statement references the need for investment based on a number of factors for example Health and Safety, changes in legislation, advances in technology and assets which are beyond economical repair. Business Unit Managers across the Company undertake condition and suitability assessments on their assets. Certain assets require specialist surveys and assessments, where these have been identified external sources have been consulted in order to gain up to date condition -assessments of assets e.g. counterbalance forklift trucks.

3.3.1 Historical Service Delivery

The graph below shows historical and forecast expenditure in Plant and other assets since AMP4 2005/06 to the end of AMP5.



Over the 10 year period displayed above from 2005/06 to 2014/15 inclusive, the average annual capital expenditure on this asset sub group is £0.56m (equating to an average AMP by AMP spend of £2.8m).

Investment in this category has remained relatively established over recent AMPs. The peak in expenditure in 2008 is associated with the replacement of the transport maintenance facility at Green Lane. The Company's historical use of assets in this category has been used to determine AMP6 requirements.

3.3.2 Delivering Future Service

Service and Cost Forecasting

The assets in this sub group provide varying functionality to all areas of the Company, to both office and field centred employees. Generally, as outlined previously, these assets are tools and equipment used to carry out the daily duties of workforces. It is essential that the Company maintains its 'duty of care' to its employees by ensuring that assets are 'fit for purpose' and maintained in good working order. Business Unit Managers across the Company have identified the continuous need for assets in this sub group and the consequences of not investing are outlined in examples below.

Distribution system management equipment is used by Customer Liaison Officers (CLO) and Repair and Maintenance teams to manage the Company's infrastructure and provide front-line service to customers. The repair teams carry out maintenance on the Company's network infrastructure using mechanical excavation equipment numerous times a day. The nature of this work is strenuous and repetitive, for example, breaking through tarmac and concrete means that this equipment gets a lot of wear and tear and exposes employees to high levels of risk if not adequately maintained. The CLOs, as well as operating the distribution network for repair and maintenance work to be carried out, perform flushing programmes to maintain the integrity of the network and also provide a variety of advisory services to customers. An example of their work includes locating leaks, which requires a need for both expertise and precise and fit for purpose equipment.

An assessment of assets over AMP5 has identified that, in addition to maintaining the current stock of plant and equipment, some additional equipment will be required and some current equipment replaced. This principally relates to equipment ensuring compliance with the Traffic Management Act and Health and Safety legislation.

Aside from repairing the distribution system, the Company utilises network management and active leakage control equipment to manage and monitor the Company's water distribution network and control leakage levels. This equipment has been identified as requiring interventions in AMP6 to allow for high service levels to be maintained. Failure of the equipment would result in leakage levels rising due to the inability to locate hidden leaks, equal to a maximum annual increase over target of 35Ml/d (the Company's Natural Rate of Rise (NRR)). As a consequence of this there would be deterioration in service being received by customers, increased levels of customer contact and failure to achieve leakage targets.

The Company continues to maintain repair and monitor its network through internal resources and in order to remain efficient and effective the Company maintains its own vehicle fleet (*see 3.6 Vehicles*). The company has a duty to ensure that the fleet is maintained to the required operational and safety standards. It is vital that the equipment used to maintain the vehicle fleet is fit for purpose, continues to comply

with current legislation and allows for maintenance to be undertaken to manufacturer standards to preserve warranty periods. Failure to invest in these assets would result in a need to hire in equipment, where possible, or have the vehicles serviced externally. Both of these options would result in increased operating costs.

The Company not only provides drinking water to its customers, it also provides a range of public amenity facilities at its Blithfield Estate, which includes a range of assets required to maintain these facilities. Interventions have been assessed for AMP6 and include interventions to where health and safety risks have been identified. Failure of these assets would render an asset unfit for purpose, removing the facility from public availability and there would be potential risks to members of the public and staff being injured whilst on site until rectified.

Planned Intervention Analysis

Analysis has been carried out by the Business Unit Managers and the need for replacement of equipment including short life 'tools' has been identified. The intervention requirements over the AMP can be attributed to a number of factors.

The Company proposes to continue to repair and replace its distribution system management tools and equipment in line with current policy and practices. The main areas where interventions are required in AMP6 relate to equipment used for excavation and reinstatement, leakage detection and to maintain the integrity of the distribution network when carrying out activities on the system in line with regulatory (DWI) guidelines. Proposed additional interventions includes the purchase of new, proven technologies in excavation equipment (spoil recycling / vacuum excavations and no dig bore holing equipment) to ensure compliance with the new Traffic Management Act and the effective operation of this maintenance function.

Investment in network management and leakage control includes equipment for a number of units in the Network Management Unit: Leakage Operations, Network Performance and Network Operations. Equipment to support the Leakage Management Strategy accounts for half of the investment within this category. Effective Active Leakage Control (ALC) is one of the critical components of an effective Leakage Management Strategy. The availability of appropriate equipment, dependent upon the asset type and attributes of a DMA, is important to the continued effectiveness of ALC operations. Leaks need to be located which generate sound below the threshold of human hearing, appropriate ALC equipment facilitates this. Long runs of main need to be effectively surveyed between mains fittings which is not possible without using the appropriate detection equipment. Plastic materials do not transmit sound effectively, requiring the skilled use of advanced equipment. For the majority of assets in this group, failure results in replacement, simply because the assets are beyond economical repair.

Investment for modelling software will improve the ease and speed of the maintenance of the newly built network model library. Improvements in software development are forecast to give the Company the ability to transfer DMA/PRV data

directly into the Network Models so giving the ability to simulate 'live' changes to the network whilst operations are undertaken or in the event of an emergency situation. Thus, mitigating further the risks associated with any of these issues on the network.

To ensure the Company continues to operate effectively interventions are proposed in AMP6 to maintain the Company's fleet maintenance facility. This includes the replacement of a number of assets that are forecast to reach the end of their serviceable life. Maintaining the internal Fleet maintenance facility is determined to be more efficient and cost effective than other servicing options, i.e. outsourcing.

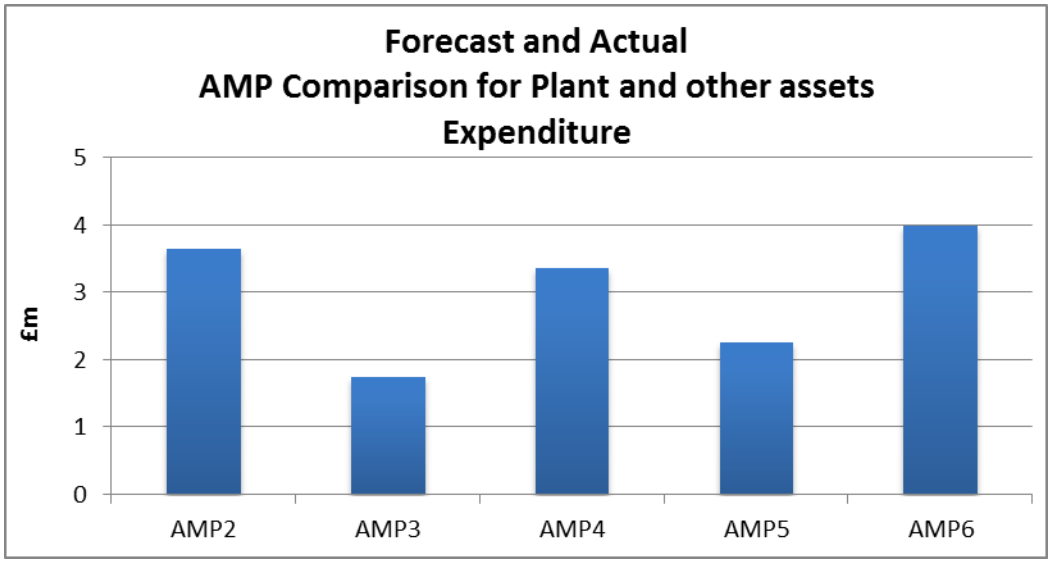
AMP6 will also see the Company continue with general maintenance of facilities at Blithfield Reservoir, a site of special scientific interest (SSSI). Interventions are proposed to prevent the asset base from becoming unserviceable through deterioration, which will be inevitable if no investment is made. Interventions to maintain the existing assets is required to ensure that the Company maintains its duty of care to members of the general public using recreational facilities provided in compliance with the Water Act 1991.

3.3.3 Conclusion

Interventions are proposed in AMP6 to maintain this asset sub group, enabling the Company to fulfil its commitments to its customers and its employees. A selection of interventions have been selected that appropriately reduces, delays or removes intolerable levels of risk, whilst operating with risk that is acceptable and cost effective to do so. All assets in this sub group enable the Company to fulfil its commitment to customers by cost effectively providing a continuous supply of high quality water. Interventions have been proposed for AMP6 to maintain these assets to ensure that the Company meets its obligations. This enables the Company to adopt an appropriate balance of risk with its water supply and distribution assets; managing the distribution network, detecting and reporting leaks and bursts, and having serviceable vehicles to be able to travel to site.

Where asset replacements are proposed these are on a like for like basis once the serviceable life has been exceeded. Advances in technology and unit costs are forecast to increase expenditure requirements above AMP5 levels. Additionally, investment in new plant and equipment to mitigate increases in the cost of aggregate and spoil disposal and to ensure continued compliance with the requirements of the Traffic Management Act is proposed.

An investment of £4.0m (gross pre efficiency) is required for AMP6 (15% of the Management & General spend). This is an increase of £1.7m on the AMP5 investment of £2.3m.



The array of assets in this category results in a variety of needs for investment. The main drivers vary from failure and risk of failure to health and safety, achievement of the leakage target and the continuation of service to customers.

The need to provide employees with the correct tools and equipment to carry out their jobs safely and efficiently is essential. Failure to invest in this area will result in operating inefficiencies, increased delays to rectify and repair customers supplies, failure to report on regulatory and legislative requirements and health and safety implications.

3.4 Offices and Workshops

The Company's non-operational sites include Head Office and Depots. All maintenance associated with buildings at production sites has been included as operational production sites. The Company pumping sites contain a variety of buildings which vary in age from the late 1800's through to today. These buildings provide the necessary protection and security to the pumping and water treatment equipment and are therefore assets which need to be maintained effectively. Buildings are long life assets and deteriorate slowly. The Company undertakes annual inspections of all of its buildings using an internal buildings management team and compiles reports detailing defects. These defects are monitored closely, using external consultant support where necessary, and interventions are undertaken when it is necessary to do so to maintain the integrity and safety of these structures.

Failure to invest in this asset group will impact upon the Company's duty of care to its employees, which will result in infringements to Health and Safety legislation. Poor condition office buildings may also have an effect on staff morale and outlook, having potential to change performance and service levels currently being achieved.

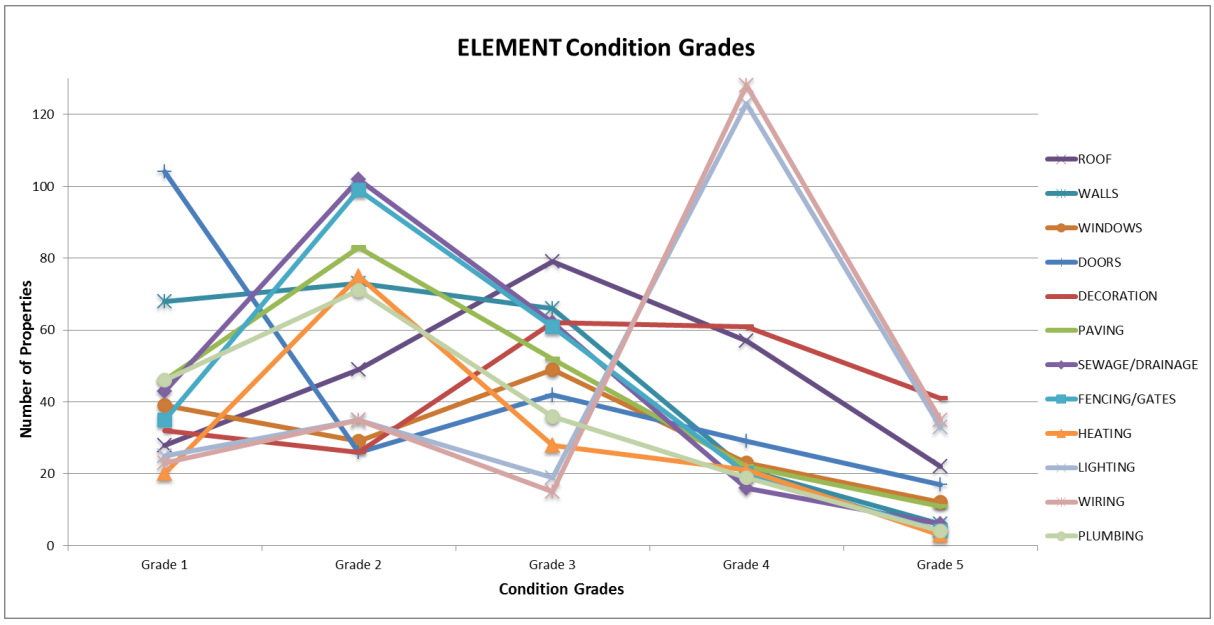
All assets in the Offices and Workshops category are recorded in the Maximo asset register and work management system. For illustration purposes the asset hierarchy for the Head Office, with the Open Plan Office Building expanded to demonstrate the asset equipment level, is shown below:

The asset register is used to hold specific details relating to asset attributes for example Supplier, Description, Model, and Serial Number.

Work management data is collected, with details of both reactive and routine maintenance being recorded. Labour hours, materials used, asset affected, work types, fault codes and causes and effects are all recorded such that the asset history can be built upon. This leads to improved asset evaluation and asset management. The data on every worksheet is checked for accuracy. Work management information collected in the field also feeds into the asset condition grading, which are revised on a regular basis, and into departmental operating budgets.

Condition grading assessments are carried out by the Company's Building Manager on a regular basis at all building locations. Assessments are carried out on the condition of walls, windows, doors, decoration, heating, wiring and other associated elements. These condition assessments are used to determine asset needs. The condition assessments are in line with the Royal Institute of British Architects (RIBA) and the Royal Institute of Chartered Surveyors (RICS) condition assessment grading.

Graph summarising condition grading of sites by sub elements.



Where direct labour is used to carry out work, man-hours and the costs of materials used are booked to each job. Costs for work carried out by contractors are invoiced and the costs are transferred from the IProcurement system to the Company's financial system, Oracle.

The Company has a Strategic Policy Statement that outlines the manner in which this asset group is managed at a corporate level:

- SPS16 – Asset Management

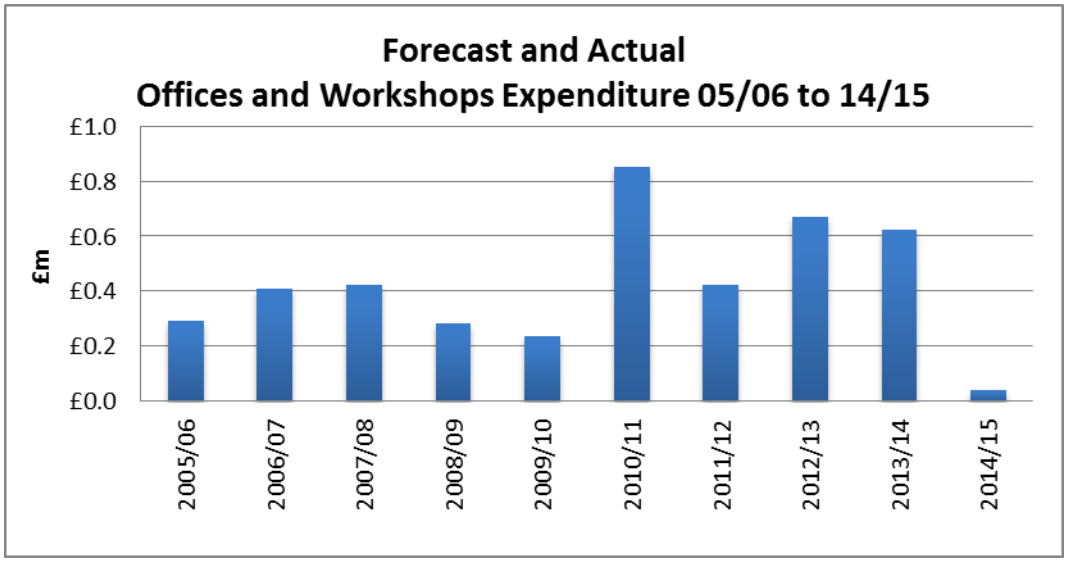
This policy outlines that the Company will optimally manage its assets by adopting asset management practices which will contribute to achieving business goals and statutory and regulatory obligations, taking into account efficiency and using existing frameworks from external agencies.

The Company also has an investment Policy Statement, which sets out specific guidelines for investing in this area:

- IPS4 – Buildings Replacement and Maintenance

This policy states that buildings will be maintained to a condition that ensures they are fit for purpose and comply with health and safety and security legislative requirements.

3.4.1 Historical Service Delivery



Over the 10 year period displayed above from 2005/06 to 2014/15 inclusive, the average annual capital expenditure on this asset sub group was £0.43m (equating to an average AMP by AMP spend of £2.15m).

Prior to this period, work was carried out between 1996 and 1999 to undertake building works at Blithfield Estate and Fradley Depot as well as office refurbishments. With the assets in this category having a longer asset life in comparison to many others of the asset groups in the Management & General category, it can be expected that the levels of spend seen in these years will be repeated in the next few AMP periods.

3.4.2 Delivering Future Service

Service and Cost Forecasting

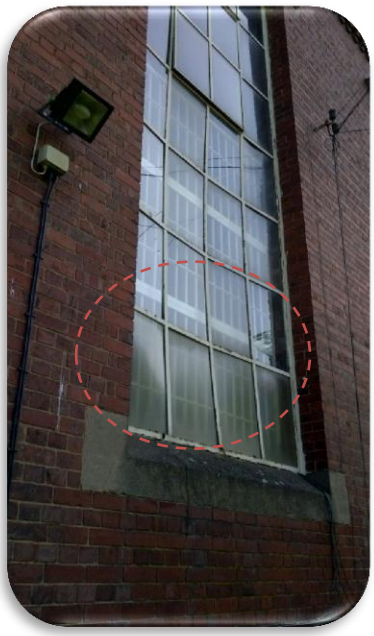
Analysis of the condition data for the Company's offices and buildings has identified interventions required on assets for AMP6. These include ensuring that the Company's duty of care to its employees is maintained, if assets within this category fail there is a risk of impact on the health and safety of staff which could result in injury. It has also been acknowledged that employee morale can also be affected by a failure to invest in deteriorating office assets. As outlined on the Company intranet the visions and values provide a framework with which the Company and the staff are expected to behave (see below):

> *"South Staffordshire Water's visions and values provide a summary of the way that we believe we should work and behave as individuals and as a company. They reflect the way that we approach our work and our customers on a daily basis, wherever we are, be it head office, on one of our sites, at a customer property, working outdoors or out on the road."*

Following significant developments in the level and detail of building condition assessments undertaken throughout AMP5, it has been highlighted for AMP6 that there is a requirement to invest in the replacement of windows, roofing and fencing which has deterioration across the Company regions.

Examples of window conditions and interventions for AMP6

W1



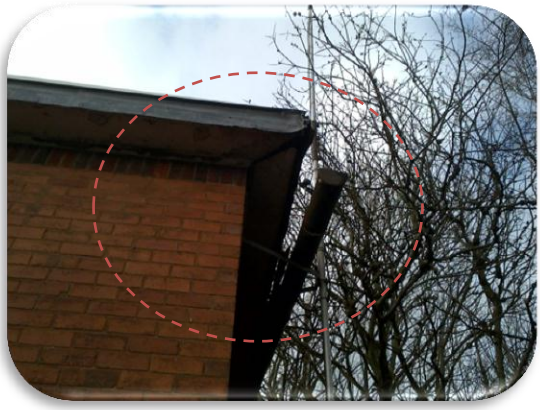
This is an example of a pumping station window which has 'bowed' within its frame. The window cannot be repaired and it has currently been assessed as 'poor'. The condition is not currently deemed to be a health and safety or security risk, however it is anticipated that during AMP6 the condition assessment will change in line with the deterioration of the window. The site remains secure due to the high level of security measures already implemented. It has been noted that with further deterioration it may pose a target for third party interference. The window highlighted above for replacement was originally installed in 1915 and the asset has been managed effectively in order to prolong their expected life.

W2

The example shown above in picture W2 has been assessed as in 'poor' condition, this is due to the level of rust present throughout. The window cannot be repaired as with example **W1** and has been identified to become structurally unsound during AMP6. The windows highlighted in this example were installed in 1933 and have exceeded their life expectancy.

Example of roofing conditions and interventions for AMP6

R1



Example **R1** is a flat roof at a booster station, which during a building survey was found to require a significant refurbishment of the membrane and soffits. Minor remedial repairs have been made in order manage its condition throughout AMP5, to allow for refurbishment to be undertaken in AMP6.

R2

The roof lining on this building has deteriorated significantly during AMP5 and is causing incorrect rain water run-off. Interior leaks have been identified, damaging the interior walls. This roof has been acknowledged for investment in AMP6 in order to negate total roof failure. Preventative repairs have been made and its condition is being managed until refurbishment in AMP6.

R3

Example **R3** shows a requirement for important remedial interventions in AMP6. The structural beams to this roof are rotten and without interventions in AMP6 it is forecasted that the structure of this roof will fail, producing unacceptable risks to operational assets and the safety of employees.

Locations across the Company area have been acknowledged as requiring interventions for AMP6 under 'Offices and Workshops' due to the presence of unacceptable levels of risk to the health and safety of employees and members of the public, including building structures, heating and ventilation installations, external walkways and tarmacked areas.

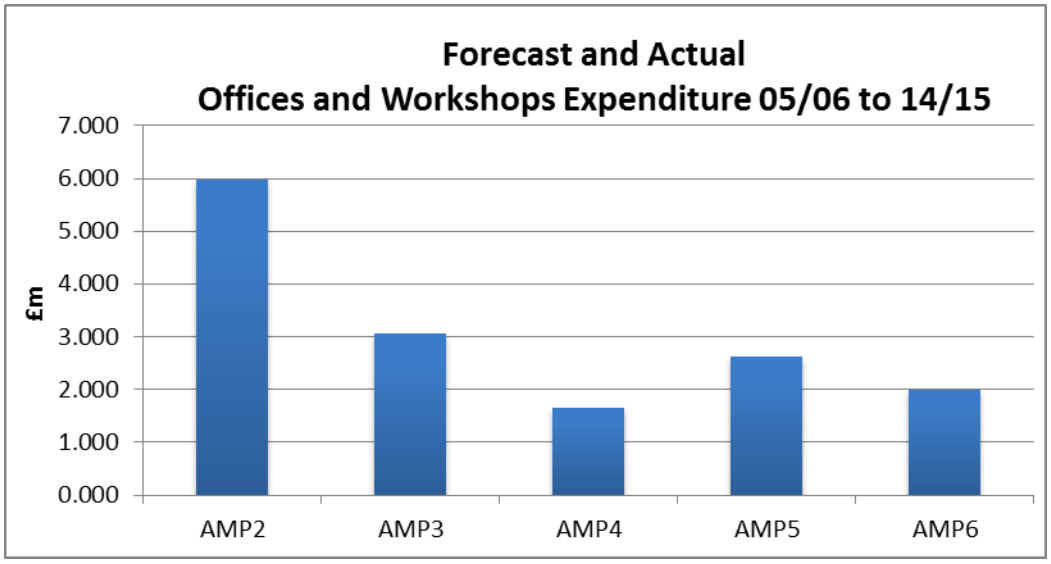
Planned Intervention Analysis

For this category of investment there are a number of options available to mitigate the risk of the deteriorating assets. When considering options available the refurbishment of long life assets such as buildings, roofs etc. have been identified as the appropriate intervention whereas total replacement of shorter life assets such as flooring has been assessed as the appropriate choice. The purpose of this investment is to maintain stable serviceability and ensure that employees have a safe and purposeful environment in which to work, to ensure the Company can provide customers with the highest levels of service.

In selecting interventions to maintain the serviceability of its offices and buildings in AMP6, the Company has adopted an appropriate balance of risk and prioritisation of investment. Only essential interventions are being proposed to maintain assets that pose unacceptable health and safety risks to employees, in recognition of continually balancing investment requirements in other areas.

3.4.3 Conclusion

An investment of £2.0m (gross pre efficiency) is required for AMP6 (7% of the Management & General spend) which is a decrease of £0.6m on the AMP5 investment of £2.6m.



Investment in this area is driven by poor asset condition and potential health and safety implications that may result from further deterioration. Failure to invest in this area will mean poorer working conditions for employees, culminating in increased risks to health and safety. Additionally a poor condition working environment may lead to a high staff turnover with a consequent loss of knowledge and expertise. It is expected that major office and building refurbishments will be required on a 25 year cycle and, therefore, a peak in expenditure on these assets is forecasted for AMP7.

3.5 Security

Investment in security measures is required to prevent unauthorised access to potable water, to Company owned assets and to protect employees. The Company has a statutory duty under the Security and Emergency Measures Direction (SEMD) to ensure that potable water sites are suitably protected to an approved standard and the standard applied has been approved by Water UK Council and endorsed by DEFRA. The use of security equipment such as, audio visual CCTV cameras and interactive alarm systems, allow the Company to operate the majority of its assets as single-man sites and react appropriately to security alarms.

Interventions are required in AMP6 for the continued operation of physical and electronic security measures; namely replacement and refurbishment of the following types of assets at depots, offices and identified production stations:

- Electronic Security Measures
    - Access Control Systems (Personnel and Vehicle)
    - Intruder Detection Systems
    - CCTV
- Fencing
- Physical Security
    - Doors
    - Kiosks / Cages

Failure to invest in this category will result in an unacceptable increase of risk to contamination of the water supply from third party interference and to a lesser extent additional operating costs following the effects of a security breach or damage incurred. Security assets are held within Maximo, the asset register and work management system. The hierarchy below is an exported example of a typical asset structure.

New Assets

Asset Name	Manufacturer	Model Number	Serial Number	Site	Location	Installation Date	Raw Purchase Cost	Proportion Cost
Colour / Monochrome Dome functional camera	Redvision	RVX-18-IR/W		Chilcote	External	01/06/2013	£1,674.00	
Colour / Monochrome Dome functional camera	Samsung			Chilcote	Pump House	01/06/2013	£1,674.00	
Colour / Monochrome Dome functional camera	Adata			Chilcote	Filter Room	01/06/2013	£1,674.00	
Boxed Smart Rio	Honeywell	P026		Chilcote	Pump House	01/06/2013	£173.00	
4 channel Vipex Encoder	Bosch	Vipex		Chilcote	Filter House	01/06/2013	£450.00	
Colour / Monochrome Dome functional camera	Redvision	RVX-18-IR/W		Churchill	External	01/06/2013	£1,674.00	
Colour / Monochrome Dome Fixed amera	Bosch			Churchill	Pump House	01/06/2013	£335.00	
2 channel Vipex Encoder	Bosch	Vipex		Churchill	Filter House	01/06/2013	£450.00	
Intruder Alarm panel	Honeywell	GD96	N/A	Barr Beacon	Dosing Building	01/01/2012	£277.00	
Colour / Monochrome Dome functional camera	Redvision	RVX-18-IR/W		Pipe Hill	External	01/06/2013	£1,674.00	
Colour / Monochrome Dome functional camera	Samsung			Pipe Hill	Pump House	01/06/2013	£1,674.00	
Colour / Monochrome Dome fixed camera	Samsung			Pipe Hill	Basement	01/06/2013	£335.00	
4 channel Vipex Encoder	Bosch	Vipex		Pipe Hill	Pump Hall	01/06/2013	£450.00	
Colour / Monochrome Dome fixed camera	Bosch			Silting Mill	Pump House	01/06/2013	£335.00	
1channel Vipex Encoder	Bosch	Vipex		Silting Mill	Basement	01/06/2013		
Intruder Alarm panel	Honeywell	GD96	N/A	Silting Mill	Basement	01/06/2013	£277.00	
Colour / Monochrome Dome functional camera	Redvision	RVX-28-IR/W	XS2802126	Moors Gorse	External	01/06/2013	£1,674.00	
Colour / Monochrome Dome Fixed camera	Samsung			Moors Gorse	Pump Hall	01/06/2013	£335.00	
Colour / Monochrome Dome Fixed camera	Samsung			Moors Gorse	Filter Room	01/06/2013	£335.00	
Boxed Smart Rio	Honeywell	P026		Moors Gorse	Pump House	01/06/2013	£173.00	
Boxed Smart Rio	Honeywell	P027		Moors Gorse	Booster Room	01/06/2013	£173.00	
4 channel Vipex Encoder	Bosch	Vipex		Moors Gorse	Filter House	01/06/2013	£450.00	
Colour / Monochrome Dome functional camera	Redvision	RVX-18-IR/W		Hinksford	External	01/06/2013	£1,674.00	
Colour / Monochrome Dome functional camera	Redvision	RVX-18-IR/W		Hinksford	Pump Hall	01/06/2013	£1,674.00	
2 channel Vipex Encoder	Bosch	Vipex		Hinksford	Filter House	01/06/2013		

Asset Capture Guide | Replacments | New Assets

Ready

Routine and reactive work man-hours, and relevant job information to support the operation of this asset group, is collected in the Maximo work management system. For work carried out by internal staff, labour costs and the costs of materials used

are gathered and details stored in the Company's financial system, Oracle. Where contractors have carried out work invoice prices are also held in Oracle. All of these costs are allocated to the appropriate department via a cost centre code. Estimates for the intervention costs associated with security systems have been sourced from the current incumbent security framework contract. Security refurbishment of site fencing and access arrangements has been estimated by the Company's Resilience and Security Manager using data from the current security framework contracts.

For effective management of the Company's security matters, policies have been developed and implemented which are applicable to this asset group.

The Strategic Policy Statement outlines the manner in which this asset group is managed at a corporate level:

- SPS5 – Security

This strategic policy outlines the intention to ensure that the production of water and supply of potable water is not susceptible to contamination and all of the legislation and government agency requirements are adhered to.

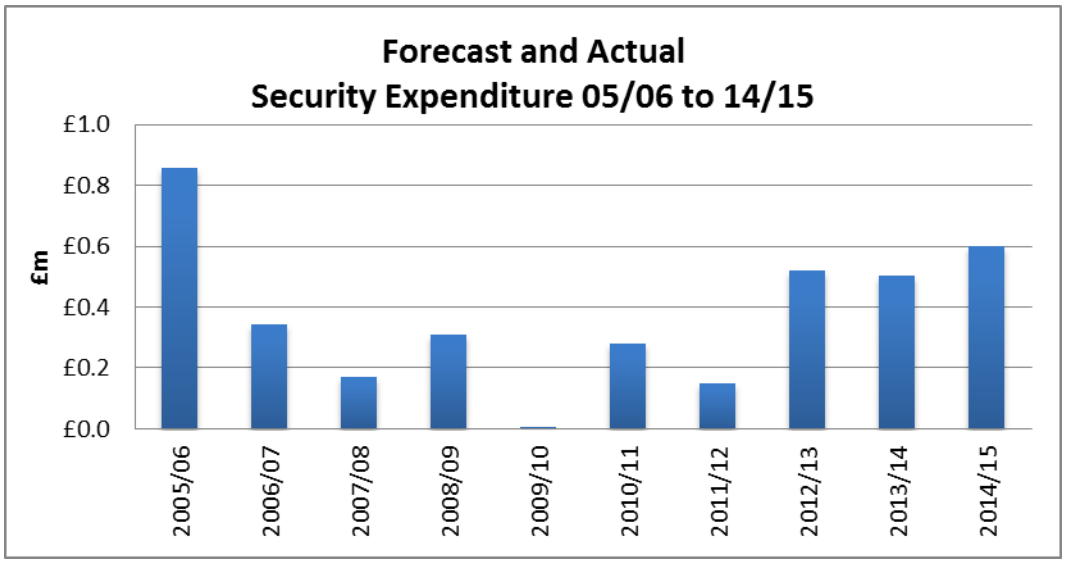
- IPS11 – Equipment Replacement and Maintenance

This policy ensures that all equipment is operated and maintained in line with Health and Safety guidelines and is replaced when the item is beyond economical repair.

- PPS666 – Security Policy Overview
- PPS660 – Access to Company Assets, Buildings and Land
- PPS933 – Actions Required Following Beaches of Security at Potable Water Installations

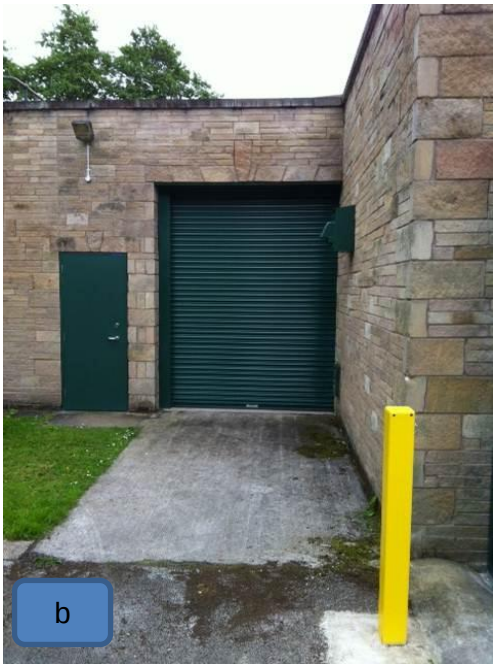
These policy procedures not only provide an overview of the general approach to security matters adopted by the Company, but also outline the details of protecting assets against theft, malicious damage, vandalism and other such acts, and responding to security breaches. Supporting these policies are the site risk assessments, carried out on a regular basis for security at all Company Production sites. These assessments review all aspects of security of a site and determine their appropriateness based on historical security incidents, strategic ranking of the site and the classification of the site using DEFRA guidance. The results are used to identify and prioritise interventions.

3.5.1 Historical Service Delivery



Over the 10 year period displayed above from 2005/06 to 2014/15 inclusive, the average annual capital expenditure on this asset sub group was £0.37m (equating to an average AMP spend of £1.85m).

Examples of security installations undertaken in AMP5



The security solutions detailed above have been installed to protect access points (a - doors and shutters) and to protect chemical delivery points and vents. Electronic solution (b - building alarms and CCTV have also been installed to provide early detection of access to a site and verification at an alarm monitoring centre to instigate appropriate operational and/or Police response.

Prior to 2005/06, security investment was included in the cost area that the building or site belonged to. Throughout AMP5 the Company continued to develop on previous extensive physical hardening of its production sites, offices and operational depots. However, this spend was historically included across the sites' appropriate Water Non-Infrastructure (RAG 2.03) category; generally under Water Resources, Water Treatment, Pumping Plant and Management & General. Therefore, direct expenditure comparisons before this time are not available.

Comparisons are further complicated by the previous DEFRA grant system for specific security related capital expenditure at strategic sites. This expenditure has since been included within the periodic review process with capital expenditure to meet new requirements, such as for SEMD now classified as Quality enhancements. Previous to this significant expenditure for SEMD schemes was classified under MNI in the relevant areas of Water Resources, Water Treatment and Pumping Stations. Over the period from 1998 to 2005 this amounted to circa £1.7m of physical hardening and electronic security measures.

3.5.2 Delivering Future Service

Service and Cost Forecasting

Failure to maintain security equipment has a number of potential effects both to customers and to the operational practices of the Company. Deterioration in the performance of security assets will lead to a failure to fulfil the regulatory requirements specified by stakeholders such as the DWI and other Government bodies. Failure to adequately secure operational depots and offices has, in the past, led to the theft of metals, vehicles, plant and machinery used by operational staff to maintain the water supply system. These thefts lead to increases in operational costs and reductions in operational efficiency. Failure to maintain short life assets such as CCTV, intruder detection and access control systems during AMP6 will result in the Company being at an increased risk of third party interference and failure to meet standards given in security advice from DEFRA. To protect customers, ensure that current stakeholder requirements and the safety of staff at single-man sites are maintained, interventions are required in AMP6 on these assets.

The identification of the investment needs at Production Sites is undertaken and monitored on a regular basis with an internal risk assessment conducted by the Resilience and Security Manager. The assessment is conducted at a site level and scored using the following criteria:

- Effect of loss of installation on water supply,
- Suitability of current security elements installed,
- Historical evidence of security incidents at site including vandalism and unauthorised access to grounds, and
- Amendments to guidance from DEFRA.

Security scopes are compiled identifying individual site deficiencies and the requirements to bring the site up to DEFRA and Water UK security standards. The scopes are used to determine the programme of works required in AMP6. This approach was also used at PR09 and throughout the AMP5 period to track day-to-day risks and to target investment effectively.

This approach has also been used in the assessment of investment requirements under the Quality, Security – Physical Hardening Improvements category. The solutions applied to improve security are those advised by the government water industry security advisors with the CPNI and are commensurate within the current perceived risk to the water industry.

A template extract from the risk assessment / scope is shown below:
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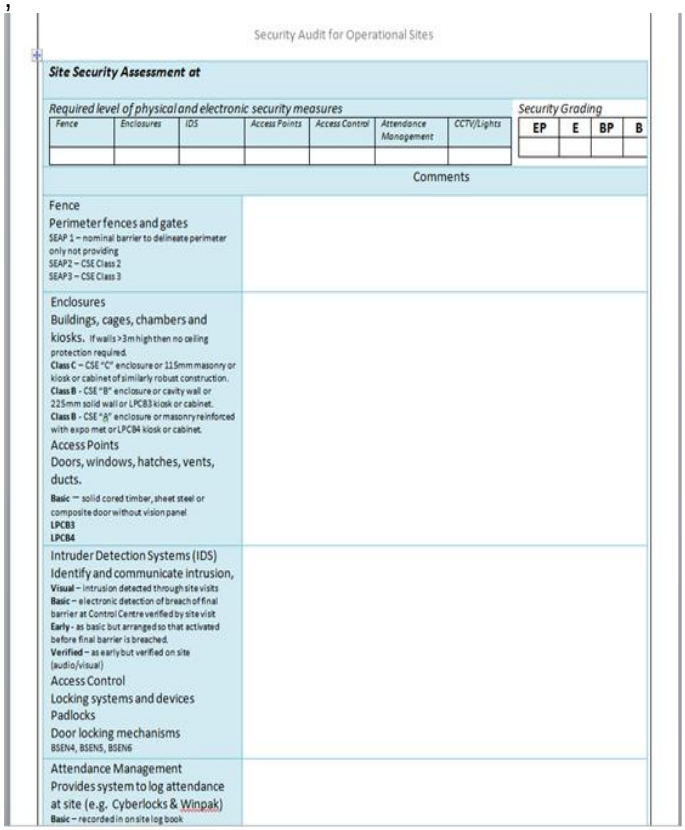


Security Audit for Operational Sites

Site Security Assessment at

Required level of physical and electronic security measures

Fence	Enclosures	IDS	Access Points	Access Control	Attendance Management	CCTV/Lights

Security Grading

EP	E	BP	B

Comments

Fence
Perimeter fences and gates
SEAP 1 – nominal barrier to delineate perimeter only not providing
SEAP2 – CSE Class 2
SEAP3 – CSE Class 3

Enclosures
Buildings, cages, chambers and kiosks. If walls >3m high then no ceiling protection required.
Class C – CSE "C" enclosure or 115mm masonry or kiosk or cabinet of similarly robust construction.
Class B - CSE "B" enclosure or cavity wall or 225mm solid wall or LPCB3 kiosk or cabinet.
Class B - CSE "A" enclosure or masonry reinforced with expo met or LPCB4 kiosk or cabinet.

Access Points
Doors, windows, hatches, vents, ducts.
Basic – solid cored timber, sheet steel or composite door without vision panel
LPCB3
LPCB4

Intruder Detection Systems (IDS)
Identify and communicate intrusion,
Visual – intrusion detected through site visits
Basic – electronic detection of breach of final barrier at Control Centre verified by site visit
Early - as basic but arranged so that activated before final barrier is breached.
Verified – as early but verified on site (audio/visual)

Access Control
Locking systems and devices
Padlocks
Door locking mechanisms
BSEN4, BSEN5, BSEN6

Attendance Management
Provides system to log attendance at site (e.g. Cyberlocks & Winpak)
Basic – recorded in on site log book

Planned Intervention Analysis

Interventions are required in AMP6 for the refurbishment of short-lived electronic security equipment (CCTV, Intruder Detection System (IDS) & Access Control System (ACS)) at Treatment Works, Offices and Depots. Interventions are also required to maintain existing physical security measures (fencing, vehicle barriers) at operational sites (Source, Boosters and Service Reservoirs).

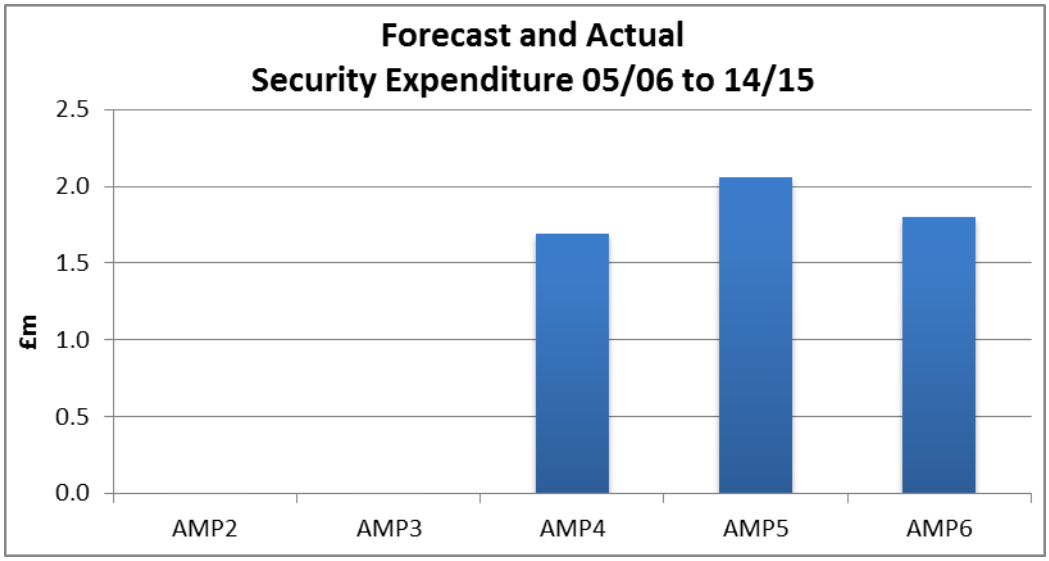
Specific detailed information relating to the proposed site security interventions in AMP6 are not listed within this commentary due to the sensitive nature of the strategic sites and the necessary interventions identified. The Company collates investment needs information from various sources, namely, from fault recording systems (Maximo and PPS 933), information gained during routine maintenance by

security system contractors, and formalised risk assessments. These information sources have been used to assess the intervention requirements for AMP6.

Options have been considered in line with the physical hardening guidelines supplied by DEFRA. Work is undertaken in accordance with PPS 660, Protection of Potable Water Installations and access to Buildings and Land, on an individual site basis, taking into consideration design, environmental and historical issues. The Company manages the diverse security requirements of its sites through the 'Security and Emergency Planning Steering Group' (SEPSG) in accordance with PPS 666 – Security Policy Overview. SEPSG includes members selected from across the business: Production, Water Quality and Resilience and Security with membership at Executive Team Level provided by the Compliance Director who is the Chair of the group. The Group meets on a regular basis to discuss issues arising, both internally and externally, to facilitate and co-ordinate information exchange and policy discussion between relevant departments within the Company on all matters of security which affect the business. The group ensures that security activities comply with Section 208 of the Water Industry Act 1991 and the Security and Emergency Measure Direction 1998 (SEMD). The Company has chosen to refurbish existing equipment only when the need arises in accordance with the risk assessment methodology.

3.5.3 Conclusion

The Company has determined an investment of £1.8m (gross pre efficiency) is required for AMP6 (7% of the Management & General spend).



This is a decrease of £0.3m on the AMP5 investment of £2.1m, at which time expenditure was required for new physical hardening measures at operational sites (Source, Boosters and Service Reservoirs). The remaining physical hardening works will be completed during AMP6 under a Quality scheme associated with meeting the SEMD requirements, in-accordance with the risk assessment methodology as specified in the Water UK 'Standard for Security Arrangements for Operational Assets'.

Investment in this asset group has been monitored and verified in recent years through external reporters during the Company annual SEMD audit. The identified investment is critical to maintain security standards at premises and to satisfactorily achieve the requirements of the Company, regulatory and other external bodies. Failure to invest in this area will result in an unacceptable increase in the risk to the fundamental operation of the Company. There will be an increased risk to the supply of water and water quality, as well as an increased risk of failure of production assets.

3.6 Vehicles

The Company operates and manages a fleet of circa 240 vehicles, including cars, vans and commercial vehicles. The effective management of the fleet is critical to the operation of fundamental functions, commitments to customers and legal obligations. All vans and commercial vehicles are the means of transportation to enable employees to carry out their basic duties, ensuring continued supply of water is maintained and customers received the highest levels of service possible. The fleet characteristics are specific, to enable employees to carry all of the tools and equipment they need to undertake their daily duties effectively, with increases in staff working from home, the vans and commercial vehicles are growing into mobile offices. Company cars are generally provided as a benefit in accordance with employee terms and conditions of employment or where an employee's work requires them to use Company vehicles as part of their duties.

As outlined in the Company's Long Term Strategy, the Company has an aim to reduce its overall carbon footprint and is a key factor taken into consideration when choosing vehicles types. Failure to invest in this asset group will result in an inability to provide the basic service of providing water to customers and will result in a decrease in operating efficiencies and the inability to maintain regulatory and legislative requirements.

For asset management and analysis purposes, and to ensure that policies and asset management practices are appropriate for the specific types of vehicle, they are categorised into the following groups:

- Commercial Vehicles
- Vans
- Cars

Fleetplan is a multifunctional system which holds the Company asset register for all vehicles and workshop equipment (*see Plant and Other Equipment*). The system, introduced in 1999/2000, holds a comprehensive list of attributes against each vehicle, examples of which are listed below:

- Registration number
- Vehicle registration date
- Chassis number
- Fleet number
- MOT expiry dates
- Road fund licences expiry dates
- Service / Repair Data & Costs

Fleetplan is also used as the fleet works management system. The data held, as outlined above, is used for a number of purposes including analysing asset, technician and driver performance information. Details of reactive work are recorded following vehicle breakdowns, faults detected whilst undertaking service/repair work or faults reported by the driver. Routine maintenance is generated from the vehicle

service schedules along with the MOT due dates. On completion of work, tasks are updated and closed with labour and materials costs collected allowing for access to a full suite of reports collated from data including service costs, repair costs etc. The data held ensures that a full history of each vehicle is available. Analysis is carried out across the fleet and is utilised to assess whole life vehicle costs to inform management intervention strategies. The data is used to control and monitor the costs of purchasing and running the fleet effectively and efficiently.

The labour costs, parts description and prices are booked to each activity and consequently each vehicle, which in turn is allocated via a cost centre to the appropriate department / Company. Cost information is transferred from Fleetplan into the Company's financial system Oracle and therefore managed by the budget holder. To monitor fuel usage, all diesel and petrol used by each vehicle is recorded on the system with costs allocated to the relevant budget and used to inform management intervention strategies.

For effective management of the Company fleet there are a number of policies which are applicable to investment in and running of this asset group.

The policies in place to govern and outline the way the Company carries out its business are:

- SPS 23 – Vehicles

This policy outlines the intention to supply vehicles to ensure that regulatory and statutory obligations are met, taking into consideration whole life costs, operational suitability, impact to the environment and customers.

- IPS 1 – Vehicle Replacement

This policy outlines that vehicles will be fit for purpose and selected according to the nature of work the vehicle will be used for, monitored cost of maintenance and repair and the risks associated with failure.

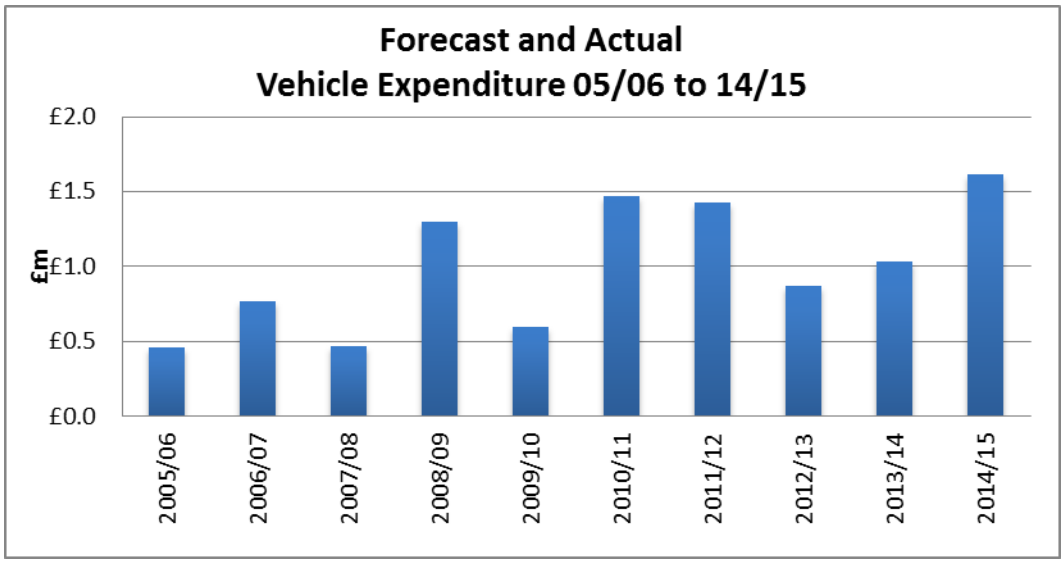
Company data, along with data from the automotive industry, is used to determine the life cycle of a vehicle and extend the asset life where it is cost effective to do so. The key factors that are taken into consideration are:

- Purpose of vehicle
- Estimated annual mileage
- Type and nature of work (e.g. local or off-site)
- Specification and quality of the vehicles
- Running costs and maintenance costs
- Residual value
- Length of manufacturer's warranty
- CO_2 emissions

Company policy is to purchase new, as opposed to used vehicles. This is for a number of reasons. Firstly, discounts between 20% and 30% have been negotiated on the purchase of new vehicles resulting in good condition used vehicles costing a similar amount to new ones. Secondly, used vehicles are far less reliable with the risk of higher maintenance costs alongside the potential of having a similar initial capital outlay. The Company has a policy to lease purchase cars and purchase commercial vans and commercial vehicles greater than 4.5 tonnes.

Annually, a Vehicle Investment Programme is submitted to the Company Board for discussion and approval. As well as outlining capital investment for the following 12 month period, this paper holds details of policy and strategy issues and changes.

3.6.1 Historical Service Delivery



Over the 10 year period displayed above from 2005/06 to 2014/15 inclusive, the average annual capital expenditure on this asset sub group was £0.99m (equating to an average AMP by AMP spend of £4.95m).

The above graph shows a decrease in expenditure during the late 1990s and early 2000s. This was due to a number of departmental functions such as plumbers, painters, pipe-fitters and grounds maintenance being outsourced. The cost of vehicles, particularly in the Vans and Commercial Vehicles category continues to increase over time, with the standard cost of a vehicle increasing by circa 2-3% per annum in recent years.

The Company has had to increase its van sizes from car-derived vans to medium vans due to changes in legislation, e.g. Traffic Management Act, and the requirements of staff owing to the amount of equipment employees need to carry. All of the larger sized vans are classified as mobile offices, again this being driven by technological advances and legislation. The vans are now equipped with trackers, welfare facilities, mobile hands free Bluetooth kits, laptop work management systems and dual batteries all adding around circa £3k per vehicle.

Following changes to working practices and manpower requirements by optimised maintenance and targeted planning, it is now common for vehicles to travel twice as many miles as will have been the case in the past. Historically, over a four year period vans would average 45,000 – 50,000 miles. However, continued monitoring shows that this is now on average to be between 80,000 and 90,000 miles over the same time period.

3.6.2 Delivering Future Service

Service and Cost Forecasting

Vehicles are a fundamental part of the operation of the Company without which the Company will not be able to meet its statutory obligations. Without intervention, vehicles will become unreliable and begin to fail on a regular basis leading to inefficiencies. Without the ability to carry out basic Company obligations, levels of customer service would deteriorate considerably. Fleet is an essential part of ensuring that customers' supplies are maintained to expected levels of service, complying with regulation and legislation.

Due to the high utilisation of the Company's vehicles fleet, wear and tear of these assets leads to regular replacement of vehicles being appropriate to ensure high levels of reliability. Changes in legislation in AMP4, included Corporate Manslaughter, led the Company to change its policy towards providing cash back alternatives to Company cars, this still remains in place moving into AMP6. A change in the Company's management structure in AMP5 has led to more staff being offered Company cars as part of their benefits package. These changes have led to an increase in the number of vehicles that are forecast to require replacement in AMP6.

Planned Intervention Analysis

Alternative options have been considered for vehicles including manufacturers, models and fuel types. As assets in this sub group are essential to the Company fulfilling its obligations to customers, consideration has not only been given to the cost effectiveness of each option but also the availability of vehicles if they were to be maintained externally. The Company has utilised industry research and tools such as the UKWIR whole life costing model, for fleet replacement. This process included a risk economics exercise to determine the balance of asset performance and economic risk. The exercise investigated the cost to the business of replacing a 'Van' after four years as opposed to three years. Using information held by the Fleet Manager; cost, probability and therefore risks have been calculated for different vehicle types. Using this data the Company has changed its policy to replacing vans from three years to four years in AMP6. If the 'Van' is purchased over four years then the vehicle has full manufactures warranty cover costs over the first three years which negates the risk to the Company. Maintenance and major component failure costs in the fourth year will, however, be funded by the Company.

The Company sees that there are additional benefits associated with more frequent replacement of vehicles and that maintaining a younger vehicle fleet reduces the

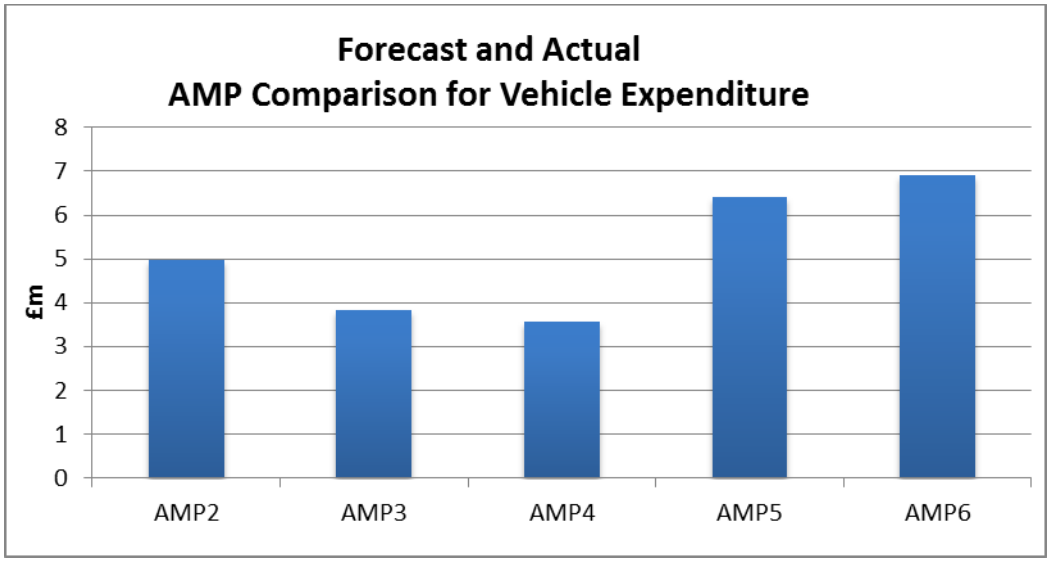
likelihood of vehicles breakdowns occurring, thus maximising the time that vehicles are available and reducing the likelihood of employees not being able to fulfil their duties. The Company takes seriously its responsibility to reduce its carbon footprint and by replacing vehicles every four years, it gives the ability to utilise up to date engine technologies longer. In a similar manner the Company has examined the appropriate asset replacement frequency of its commercial vehicles. Company policy is that these vehicles should continue to be replaced on a seven to ten year cycle, during AMP5 the replacement of these vehicles has been managed beyond this, with a number of commercials being targeted for replacement in AMP6.

In accordance with approved policies in place to manage Company's fleet effectively, and in order to continue effective operation, the Company will need to purchase the following vehicles in AMP6:

Vehicle Type	Replace once during AMP6	Replace twice during AMP6	Total number of vehicles
Cars	20	31	51
Vans	151	14	165
Commercial Vehicles	19	0	19

3.6.3 Conclusion

An investment of £6.9m (gross pre efficiency) is required for AMP6 (26% of the Management & General spend). This is an increase of £0.6m on the AMP5 investment of £6.3m.



This proposed increase is driven by a number of factors including:

- An increase in the size of the Company's vehicles fleet in AMP5 leading to more vehicles requiring replacement in AMP6

- A higher unit cost of vans and commercial vehicles due to the need for additional equipment following technological advances and increased business requirements
- An increase in the utilisation of vans and commercial vehicles leading to additional maintenance requirements
- An change in the replacement frequency of vans during AMP5 leading to more vehicles requiring replacement in AMP6

4. Customer Engagement and Challenges

The Company's plan for interventions required for Management and General assets in AMP6 has been through many iterations of challenge internally using the Company's own processes and externally using the Customer Challenge Group (CCG) directly and also further independent engineering scrutiny commissioned by the CCG.

4.1 CCG Challenge and Commissioned Engineering Scrutiny Audit

The CCG deemed necessary that an external audit of the Company's capital maintenance plan to take place, whereby challenge could be focused through an engineering scrutiny report produced by a professional with experience in dealing with technical engineering projects. The Company welcomed this audit, as it was an opportunity to validate the outcomes of the Company thorough asset management processes and the engineering needs of the Company asset base going forward. Whilst doing this it was engaging the Company proposals and business planning processes with the CCG. The table below lists the challenges made towards the Management and General Business Strategy and the responses and actions made by the Company.

Challenge
(a) Integrating the Cambridge Region into any SCADA upgrades and that the requirements be fully developed and scoped before the project is approved for inclusion within the investment programme. (b) That the implications of integrating the proposed GIS system into the Cambridge Region be fully explored before any procurement process is commenced
Company Response
Following the acquisition by SSW of CW, current expectations are that all fundamental IT applications will be integrated in both regions with the exception of GIS and SCADA by March 2015. For GIS and SCADA, a holding position will be determined for AMP5 until a collaborative replacement project for both will see each replaced early in AMP6. For SCADA, an engineering work package has been identified to provide short-term resilience against unrecoverable system failures. This will enable both regions to continue using their current solutions in a business-as-usual capacity until an early AMP6 replacement. SSWs team of experienced system engineers routinely specify, configure and commission SCADA systems for both internal clients and as part of the unregulated business. As such, they are familiar with both the technical challenges and costs associated with this type and scale of project. This has enabled them to work with a leading water sector SCADA supplier to establish a firm initial costing that is representative of the general market place. Due to the interdependence of SCADA with other information technologies within the wider business, further cost refinement can only be achieved during pre-tender design activities, which will

commence in late 2013.

For GIS, both regions will continue to use their current solutions however, the deployment of Maximo into CW will present a challenge if CW adopts Maximo Spatial (embedded GIS). As this solution is underpinned by SSW's current GIS system, there are technical considerations that cannot be determined until the design stage which is expected to commence late 2013. So a definitive holding position for GIS cannot be determined at this point but it will be a consideration of the Regional Integration Programme and transition roadmap.

The replacement of CAM and SST regional SCADA systems is being undertaken as a single integrated project focused upon the alignment of standards, operating processes, information technologies and communication networks across the company as a whole.

This approach is crucial in ensuring that operating efficiencies, such as those identified around plant optimisation and control office consolidation, are fully leveraged when the new SCADA system is set to work.

The adoption of this approach is demonstrated in the activities being undertaken by the Company prior to commencement of the AMP6 replacement, which include extensive business process mapping and alignment within the control office environments, the consolidation of technical standards, and various technical project 'enablers' such as the extension of SST telemetry communications to CAM production sites and replacement of incompatible hardware.

Finally, to further enhance integration in this area, responsibility for all industrial control systems now falls under a single unit function that operates across all company areas.

CCG Position

Accepted with undertaking from Company that replacement is being undertaken as a single integrated project across the whole Company.

5. Conclusion

5.1 Methodology Summary

The Company for its Management and General assets has utilised a wide range of data sources, including condition data, to determine intervention needs for AMP6. Interventions have been determined to cost effectively, supported by CBA, maintain stable levels of service to customers, as set out in the Company's Long Term Strategy and Company policy. In selecting the interventions that are required over the AMP6 period the Company has adopted an appropriate balance of risk to maintain service whilst minimising the impact on bills.

The Company proposes intervention in all areas of Management and General is to maintain stable serviceability and address unacceptable levels of risk. Two areas of significant investment are:

- IT, which will ensure operational activity is efficient, changing customer expectations for service are met and debt levels are managed
- Vehicles, where technical advances have resulted in an increase in the unit cost of each vehicle and where an economic risk review has impacted upon the replacement cycle

Cost benefit analysis has been undertaken on 92% of the proposed AMP6 interventions and 88% of expenditure is positive. The remaining interventions that are valued as CBA negative and have been included are either, important in providing current levels of service, supported by Company Policies, have been difficult to value the benefits and have been challenged by Directors, and deemed necessary to effectively and efficiently run business operations.

5.2 Summary of Historical Investment and Delivery of Future Service

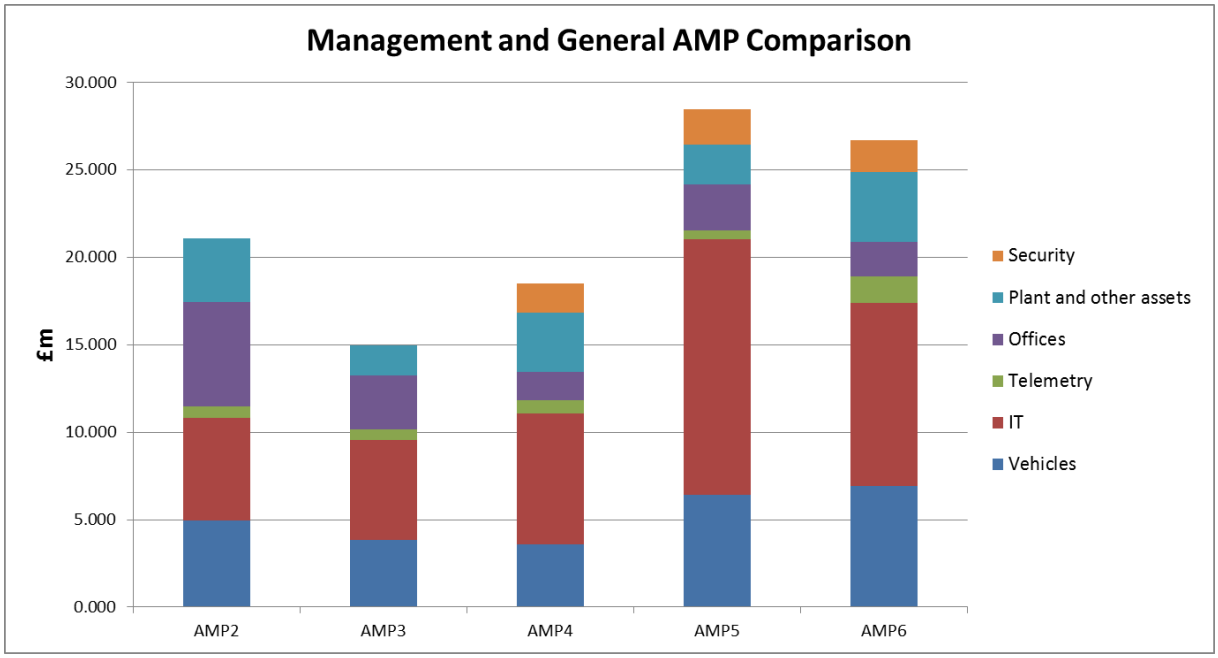
The key interventions required in AMP6 in the six sub assets groups are:

- IT – The development of software to meet the increasing customer expectations and manage debt and hardware to ensure that a stable, reliable and secure platform is maintained to ensure that risk of failure is minimised.
- Telemetry – System upgrades of SCADA to ensure the 24/7/365 availability of the system to support continued reliability of the key assets essential to the operation of a business as usual system.
- Plant and Other Assets – To ensure that employees are equipped with tools that are fit for purpose and to support customer operations whilst ensuring that activities are carried out safely
- Offices and Workshops – Investment in this area will address assets which are in poor condition such as the roofing and brick work at outstations and flooring at Head Office.

- Security – The continuation of physical security measures and replacement of CCTV, Intruders Detection System and Access Control System to maintain security standards at premises
- Vehicles – The replacement of vehicles to ensure that the Company are able to fulfil its basic obligations to customers cost effectively.

Assets in this group affect all aspects of the Company's business and therefore support the delivery of all aspects of service to customers. The key driver for the proposed AMP6 interventions is to ensure the Company continues to cost effectively maintain high levels of service received by customers. The need to replace more equipment in AMP6 utilised by Company employees and the need to replacethe Company telemetry system to ensure the continued reliability of systems are driving increases in the proposed levels of expenditure in these categories.

The graph below represents the expenditure for previous AMP's compared to forecast of AMP6. The historical investment in the Company's fleet has previously been less than AMP5 and projected AMP6 investment, due to more recent changes in expectations of customers, legal requirements and operational requirements. This has seen an increase in staff levels and the types of vehicles being purchased for employees to undertake required tasks. With regards to the continuation of IT expenditure on previous AMP's, the changes in customer and operational requirements means that the Company needs to keep pace with the evolving expectations of customers and technology base.



The required AMP6 capital maintenance interventions for Management and General assets will be delivered by Business Unit Managers. Whilst the proposed AMP6 interventions lead to a greater level of expenditure than was required in AMP5, this increase can be delivered by the Company using 'business as usual' procurement and delivery processes. Phasing is linked to risk and those assets at high risk are phased earlier in the programme, such as the telemetry replacement. The Company has ensured, through internal validation that these phasing's can be achieved.

South Staffs Water

incorporating

CAMBRIDGE WATER COMPANY

Metering Investment Strategy

December 2013

Metering

Supporting outcome 2 (Secure and reliable supplies - now and in the future)

Supporting outcome 3 (An excellent customer experience to customers and the community)

Supporting outcome 4 (Operations that are environmentally stable)

Supporting outcome 5 (Fair customer bills and fair investment returns)

The Company believes that metering strategies form an important part of helping customers understand their water use and provide them with opportunities on how they can manage/change their water using habits.

Why Meter?

- Research shows customers generally agree metering is fair
- Environment agency are supportive
- Encourages conservation and rewards efficiency
- Can help customers with budgeting
- Supports energy and carbon reduction for the Company and the Customer
- Demand management tool
- Enhanced supply pipe leakage identification

The Company is committed to aligning metering strategy and policy appropriate to the needs and benefits of the customers in each region. It is intended to manage this in a transitional way using the opportunity of having different technologies, approaches and experiences to determine optimised solutions.

The decisions on future metering and new supplies levels influence both demand and income forecasts and have been determined in this plan to be credible. During the current economic climate it is quite difficult to accurately forecast for example the Company is having to predict the speed of economic recovery, the credibility of local authority new housing development plans and also predict customer behaviour and attitudes to metering.

From an asset perspective meters are critical components that the customer and Company rely upon to accurately record consumption. They are mechanical devices that do not have unlimited life.

Across both regions there is a range of meter stock installed above and below ground ranging from ‘dumb’’ eyeball read meters through to remote wired touchpad meters and early versions of radio read meters. When identified as no longer working the meter replacement is a priority task. In the South Staffs region a proactive aged base replacement strategy has been implemented in AMP5 with the aim of having no meter older than 15 years.

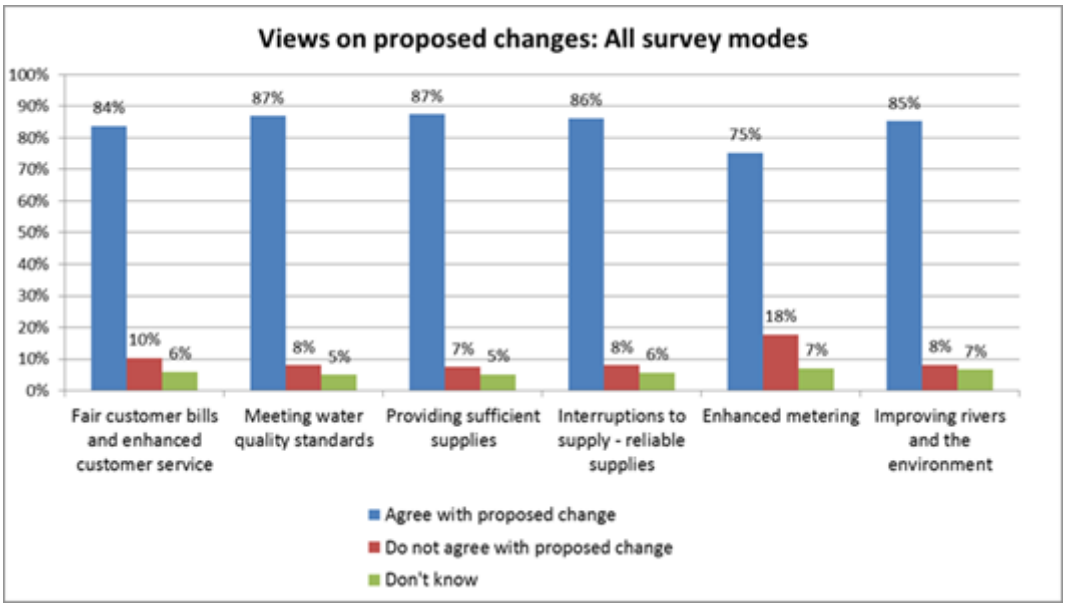
Meter Policy

The Company proposes to continue with the following existing metering policies in both regions:

- Free meter policy – household customers can opt for a meter free of charge with a 12 month reversion period for domestic customers.
- New supply policy – all new household and non-household properties must be metered.
- Compulsory metering policy for customers with swimming pools or ponds greater than 10,000 litres capacity
- Compulsory metering of household customers wishing to use unattended garden watering devices

In addition, in the South Staffs region the Company will continue with change of occupier metering policy commenced in April 2010, where meters are installed in certain properties when they change occupier; and will also continue with compulsory metering of all non-household properties across both regions.

The Company's CCG is supportive of the continuation of the discretionary policy of change of occupier metering, as they consider it to be a sensible way to achieve greater domestic meter penetration levels over the long term. Metering is supported by customers but they also want bill impacts to be minimised. Hence since the Company has a supply surplus, taking an approach that leads to moderate metering growth is seen as the right balance. The following table shows ICS acceptability on enhanced metering.



In consultation on long term strategy CCW have endorsed the decision to continue with Change of Occupier Metering - *"We believe that the company's proposed plans represent a sensible and steady progression of metering. We also support the proposal for metering on*

change of occupier in the South Staffs region as customers in the region clearly think this is the fairest way of charging." [1]

The Environment Agency has also given support to the continuation of the Change of Occupier metering policy which features in the Company's Water Resources Management Plan.

In the South Staffs region the Company currently has a relatively low proportion of metered household customers (current meter penetration is approaching 30% of billed properties compared to an industry average of just above 40%). Domestic meter penetration will rise from the current level of around 30% to 40% at the end of 2019/20.

In the Cambridge region domestic meter penetration is much higher at 66% and this is forecast to rise to 74% by the end of 2019/20.

Free Meter Optants

The Company has reviewed the actual number of meter optants experienced over the last seven years and the latest forecasts for the two remaining years of the AMP5 period to guide the likely number of optants going forwards. Whilst there has been variation in the number of optants installed year on year the averages for the five year periods 2005/06 to 2009/10 and 2010/11 to 2014/15 are relatively stable.

Year	Actual / Latest Forecast Number of Meter Optants	
	South Staffs	Cambridge
2005/06	5,224 (Actual)	1143(Actual)
2006/07	6,185 (Actual)	1456(Actual)
2007/08	4,344 (Actual)	1367(Actual)
2008/09	7,215 (Actual)	1411(Actual)
2009/10	6,322 (Actual)	1288(Actual)
2010/11	4,587 (Actual)	1192(Actual)
2011/12	5,992 (Actual)	1047(Actual)
2012/13	6,632 (Actual)	1214(Actual)
2013/14	6,400 (Forecast)	1200(Forecast)
2014/15	5,900 (Forecast)	900 (Forecast)
Average	5,880 (Actual)	1265 (Actual)

Therefore the Company is forecasting that on average 5800 (SST) and 1265 (CAM) optional meters will be installed per year for the period 2015/16 to 2019/20. This reflects the current trend for customers to use metering as a way to control household bills.

[1] Extract from Consumer Council for Water response to 'Our long-term strategy – A south Staffs and Cambridge Water Consultation ' 6 September 2013

Change of Occupier Metering – South Staffs Region

The Company introduced change of occupier metering in 2010/11. The actual number of properties metered under this policy has been significantly impacted by the decline in the housing market.

Year	Actual / Latest Forecast Number of Change of Occupier Meters
2010/11	2,144 (Actual)
2011/12	1,951 (Actual)
2012/13	1,506 (Actual)
2013/14	1,800 (Forecast)
2014/15	1,800 (Forecast)
Average	1,840

The Company proposes to continue with change of occupier metering as a baseline metering policy

The number of properties forecast to be metered under this policy during the period 2015/16 to 2019/20 is 2000 per year. This reflects the Company's view that the downturn in the housing market will continue to impact the number of properties available to be metered under this policy.

Customer Meter Replacements

Meter Replacements – Cambridge region

Currently 89,908 meters are in situ. 82% of commercial customers are metered, 66% of domestic customers are metered. In Cambridge the current policy is to only replace meters on failure or where there is a customer service benefit e.g. where other works are being carried out such as lead renewals and the current meter does not fit the current metering requirements.

There is no programme of proactive meter replacement in place as this has previously not been determined cost beneficial in the Cambridge region.

Forecasting replacement numbers remains consistent with the approach taken at AMP5. Failure data is captured through the Cambridge works management system and billing software. This data has been used to develop failure curves which then can be applied to the existing meter stock, which then produces the forecasts. As at AMP5 the number of battery operated meters which will have a more certain finite life than majority of meter stock has been factored into forecasts. These are accounted for based upon the manufacturers determined battery life.

During AMP6 it is anticipated that the number of meter replacements will significantly increase. This is due to the installation profile seen in the mid-1990s. 41 % of current meter

stock was installed within a five year period between1995-2000 and it is forecast that these meters will begin to reach the end of their lives in the AMP6 period.

In total in AMP6 it is anticipated that over 13,000 meters will require replacement, at PR09 the forecast was for 6000 meters so the forecast for AMP6 represents a doubling of rate of replacement. The current 2013-14 actual unit rate of £152 (Direct cost only) has been used to calculate the total costs of replacing the meters. This means that the total direct cost spend is anticipated to be in the region of £2 million in AMP6. This compares to £1 million (2007/08 prices) at PR09.

This is consistent with what was stated at PR09. It was stated then that AMP6 would see a significant increase in replacements which will peak in AMP7.

The peak in AMP7 increase may also be exacerbated by the technology change adopted in AMP5. Due to reduced demand, manufacturers have stopped producing the touchpad technology meters (encoded) and so Cambridge were forced to make the decision between the backwards step of visual reading meters or move with the rest of the industry to radio reading.

Pre-merger, the decision was made by the Cambridge Metering Management Group to move to AMR meter reading. These meters, however, although the measuring element remains mechanical, the transmission of the data is reliant on an inbuilt battery unit. Although non-replaceable the life of the battery is guaranteed for 10 years so it is anticipated that these meters will begin failing after that point, which would potentially impact in the AMP7 period.

Meter Replacements – South Staffs Region

Although the decision by Cambridge to move to AMR meters was made pre-merger, it was in effect the same decision made by South Staffs commencing from AMP5.

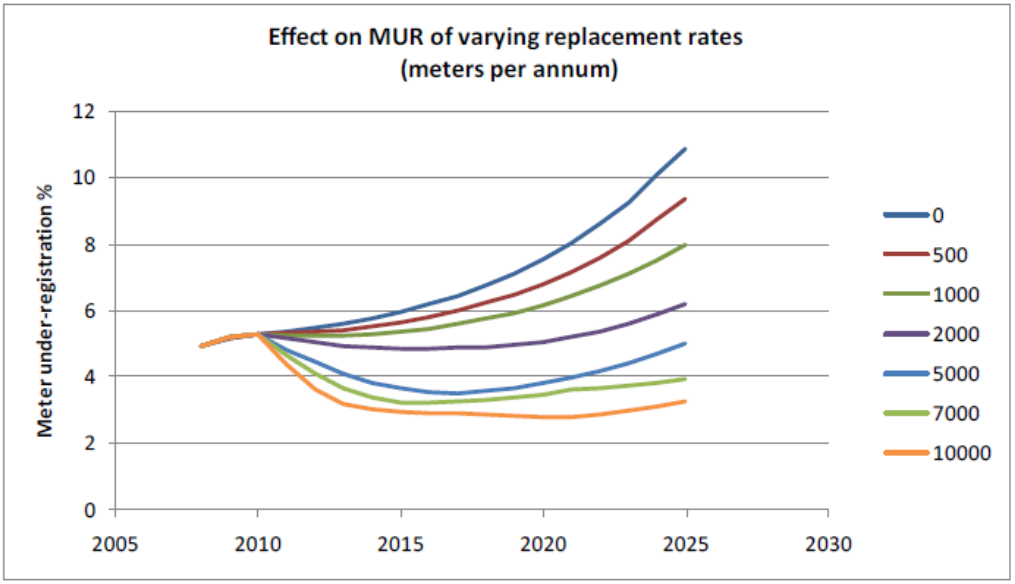
Through industry wide and specific research South Staffs have determined a wider scope for meter replacement to consider the impact of meter under registration pre-complete failure (ie). stopped meters. This has focused the meter replacement activity in the South Staffs region and the proposed continuation of a pro-active replacement strategy operating to mitigate the cost of an otherwise increasing number of reactive replacements and loss of revenue from under recording meters.

AMP5

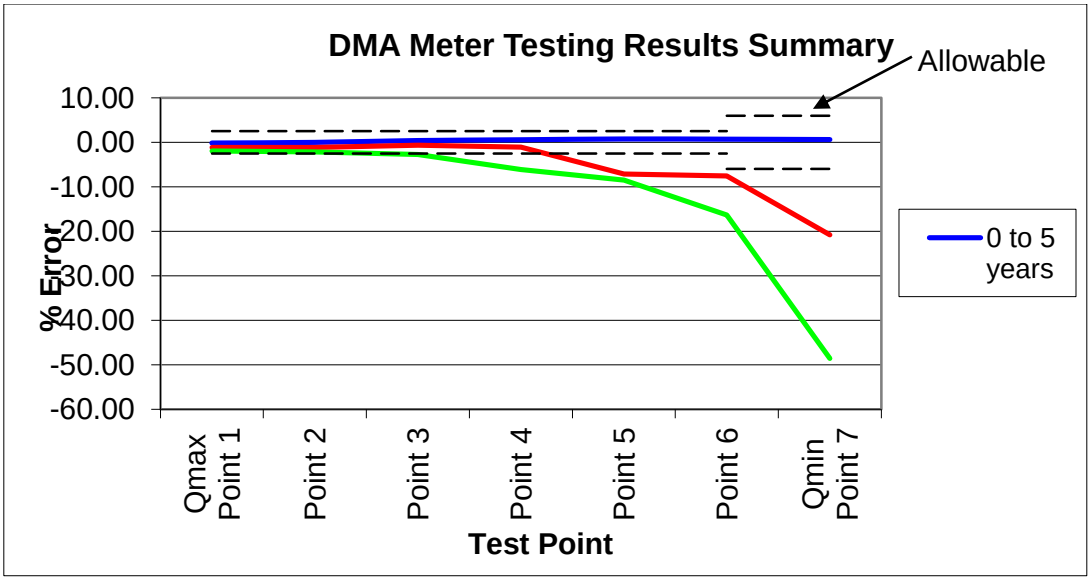
The basis for the AMP5 replacement strategy was the level of meter under registration (MUR) identified in the Company's meter assets. Consultancy firm Tynemarch carried out analysis from 350 sample meters tested over 7 flow rates and developed a spread-sheet model and associated report to support the Company's business case.

The analysis highlighted specific deterioration in Schlumberger meters and general wear of the device over age. Furthermore it was identified a target of 5000 replacements per annum would help the Company successfully reach the industry average level of MUR of 3.64% by 2015. The replacement strategy for PR09 set out a target of 5000 meters per annum with Schlumberger meters and age the primary and secondary considerations respectively.

The Company replacement policy of 15 years is based on Water Industry benchmarking standard replacement cycle and indicates we should be aiming for a position of no household meter being older than 15 years.



Testing of non-household meters was focused on DMA meters and domestic sized metering. This data was collected specifically to understand performance of large customer meters (but can be supported by DMA meter testing data as they are the same types and sizes of meter). Testing in this area will be on-going.



AMP5 Progress

Progress with the AMP5 target of 25,000 household and 2,500 non-household meter replacements remains on course to be achieved.

Activity	2010-11	2011-12	20012-13	2013-14	2014-15	Total
Nr. Household Meter Replacements - AMP5 Target	5000	5000	5000	5000	5000	25000
Actual / *Latest Forecast*	4666	5298	3795	*6327*	*4914*	*25000*
Nr. Non-Household Meter Replacements- AMP5 Target	500	500	500	500	500	2500
Actual /*Latest Forecast*	616	367	301	*925*	*500*	*2500*

The AMP5 replacement strategy of 5,000 household and 2,500 non-household meters per annum results in an approximate total of 18,350 meters remaining over 15 years. The Company determines that an on-going consistent approach to management of meter stock is required for AMP6 to ensure that meter age and consequential under registration are effectively managed.

With large increases in meter numbers following the introduction of Free Meter Options in 2000 and the natural recurring effect of the replacement programme means that an increased level of replacements will be required in future AMPs if the business is to avoid a deterioration of the meter age profile and significant increased levels of reactive replacements of stopped meters.

Tynemarch Model Update

The Company has adapted the model to help identify an optimum level of MUR based on the projected cost of replacement compared to the lost revenue from MUR in the Company's meter stock. This analysis has also included an additional 400 meter tests compiled since PR09. The optimum level of MUR has been determined as 3.2%, this is demonstrated in the following Tables 1 & 2.

Meter Stock Age

By the end of AMP5, at the current replacement level of 5,000 meters per annum, an approximate total of 18,350 meters will be over 15 years old. With no meter replacement programme in AMP6 this would escalate to 51,950 meters being greater than 15 years old.

It is therefore concluded that to achieve the 'no meter older than 15 years' target the meter replacement programme should continue and be increased based on the Company's household meter stock. This is due to the impact of Free Meter Options from 2000 and the natural recurring effect of the replacement programme (i.e. meter replaced in 2010 will need to be replaced again in 2025)

Table 1. Optimum Meter under registration

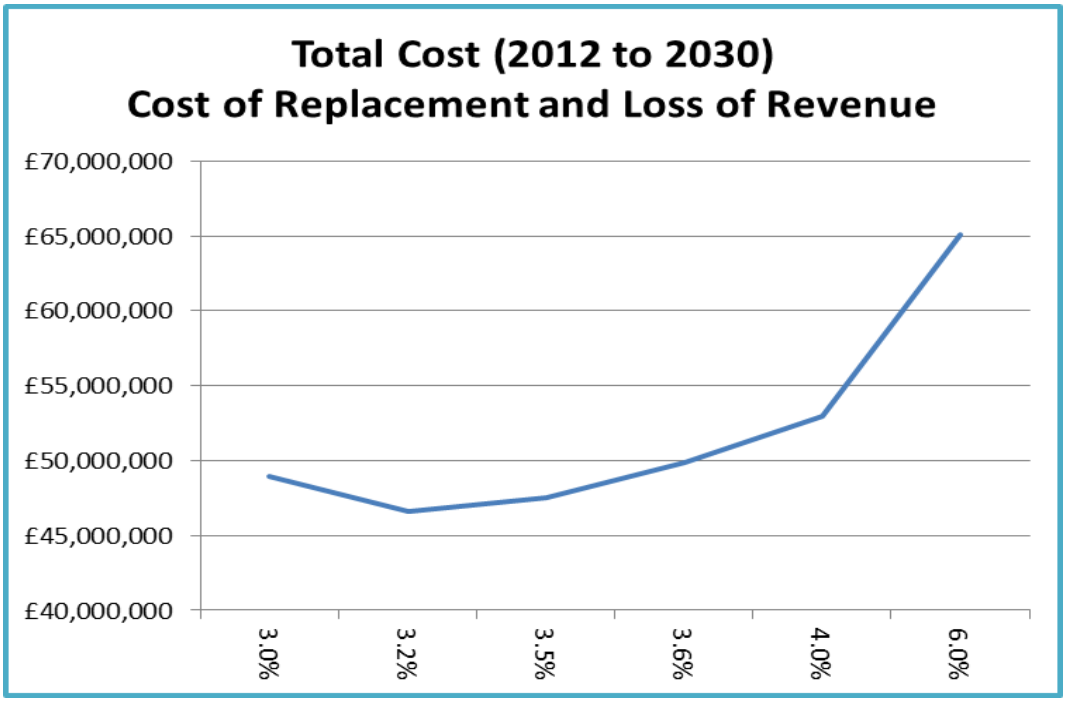
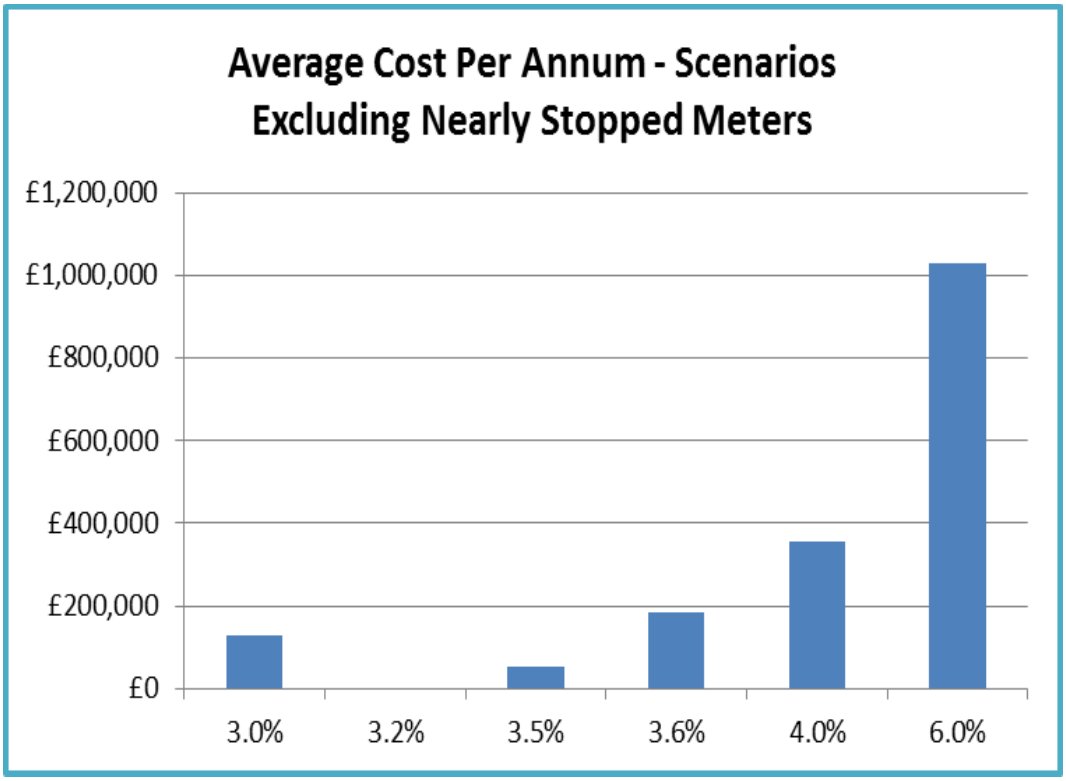


Table 2. Optimum Meter under registration



The number of replacements required to meet a constant 3.2% level of MUR is shown in Table 3. and indicates an annual replacement strategy of 5,000 meters in AMP6. This escalates to 9,000 meters in AMP7 and 20,000 meters in AMP8 to take into account a 2nd cycle of replacements.

Nearly Stopped Meters

An emerging issue identified from the MUR analysis has highlighted up to 7,000 nearly stopped meters with consumption less than 50 litres per property per day. The MUR analysis is sensitive to this and indicates the level of MUR increases to 3.98%, requiring the total number of annual replacements to increase to 7,000 in AMP6.

Further trials and investigations are underway to understand this issue with a sample of 170 'nearly stopped' meters is planned for replacement in October 2013 to help facilitate this.

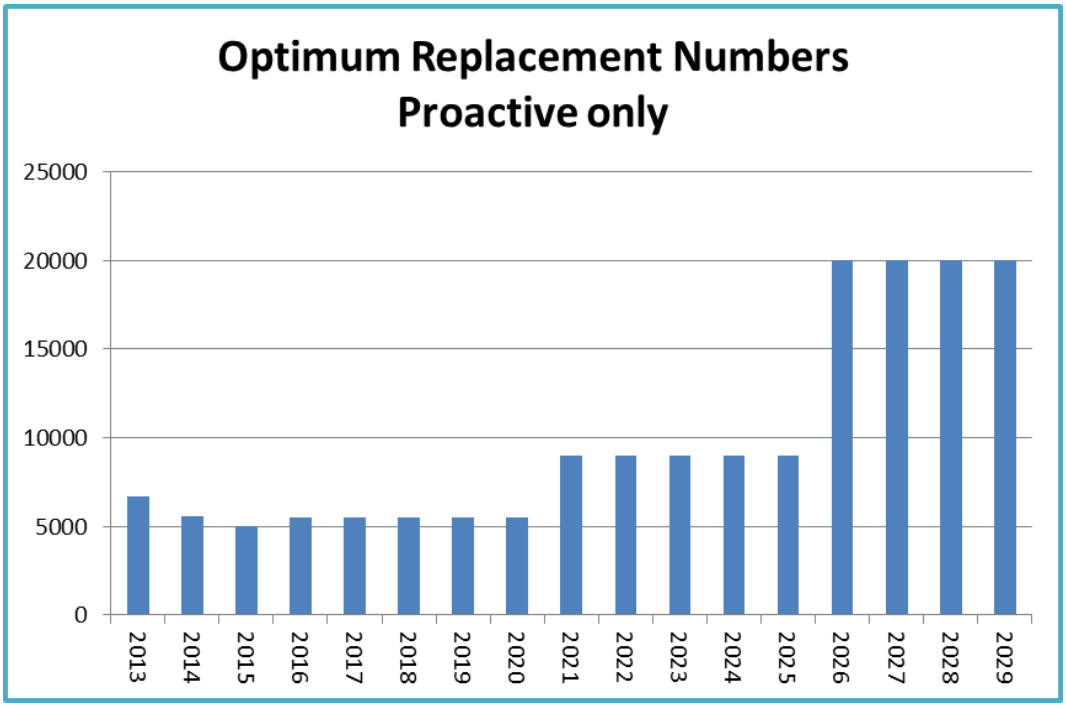
Optimum AMP6 Replacement Strategy

The investment drivers for pro-actively replacing meters are based on income loss and future uplift of costly reactive replacements derived from an aging meter stock. Internal Company analysis alongside industry research demonstrates that meters will deteriorate as they grow older; this depreciation has an impact on the accuracy of the meter as the consumption will under record.

The meter under registration (MUR) measurement will be based on age, type and throughput of the household meter, but studies prove it can as high as 20%. This therefore has an impact on income generation from a level of inaccurate billed consumption from domestic customer usage.

Table 3 represents the profile of optimised programmed replacements.

Table 3 - Optimum Level of Replacements



The meter replacement programme supports the following Long Term Strategy key outcomes :

- Delivering an excellent customer experience to customers and the community- the programme facilitates efficient deployment of new meter technology enabling enhanced customer services such as remote meter reading, consumption history data, and leak alerts. The future potential to tie into SMART utility networks is also enabled.
- Fair customer bills - accurate meter readings are the basis of a measured billing system, they are the cash register for the Company and the cost evaluator for the customer. All parties need to have confidence that the meter is working within its required levels of performance.

AMP6 Programme

The replacement programme has been developed to cater for an aged meter stock which will reduce as the programme continues. During AMP5 the aged meter stock has been reducing and this will continue to be the strategy during AMP6 with a 'no meter older than 15 years' (to align to Company policy) being reached by early AMP7. Beyond this target the strategy is based around maintaining this level and replacing meters each year that have reached a 15 year life.

Pro-active meter replacement is a long-term strategy to replace old, vulnerable assets to reduce future levels of costly reactive replacements. Without proactive replacements there is a risk of an escalating number of household meters stopping or failing. This will result in an increase in high-cost reactive replacements, customer interaction and billing recalculations. This will worsen as the measured household base grows. Proactive replacement will mitigate against future, long term cost associated to reactive work in response to meter failure.

The investment gain is difficult to define as the replacement strategy is a long-term process to reach stability within the Company's household meter assets in terms of meter-under-registration and failure which has added benefits to the Company and customer. Further analysis is currently on-going to define an understanding of the cost and benefit associated with household MUR.

A further benefit of the programme is the ability to carry out clusters of replacements in selected areas. This not only enables the cost to remain low but creates small pockets of meters with automatic meter reading(AMR) capability which can achieve efficiency in meter reading of up to 80% when compared to traditional 'eyeball' or 'touchpad' reading methods.

Automated Meter Reading (AMR)

In both regions AMR meters are now installed in new installations, Itron in South Staffs and Elster in Cambridge, there is no immediate appetite to quickly move to a single meter supplier. There is a significant opportunity to monitor and review the performance of both meters and reading systems to identify which offers the best solution.

AMR meters are now being deployed in both regions enabling:

- Quicker and multiple readings
- Recorded frequency of readings
- Substantial reading ranges
- Indications of potential leakage
- Alerts – Backflow, battery, tampers

The benefits AMR meters offer are not only significant to mitigate against meter reading costs but are also necessary as the relatively efficient outgoing touch-pad metering becomes obsolete and reversion to dumb meters and eyeball reading would be a regressive step. AMR meters do require batteries and so will drive replacement based on a battery life of 10-15 years. This also coincides with the aim of having no household meter older than 15 years.

Engineering Scrutiny

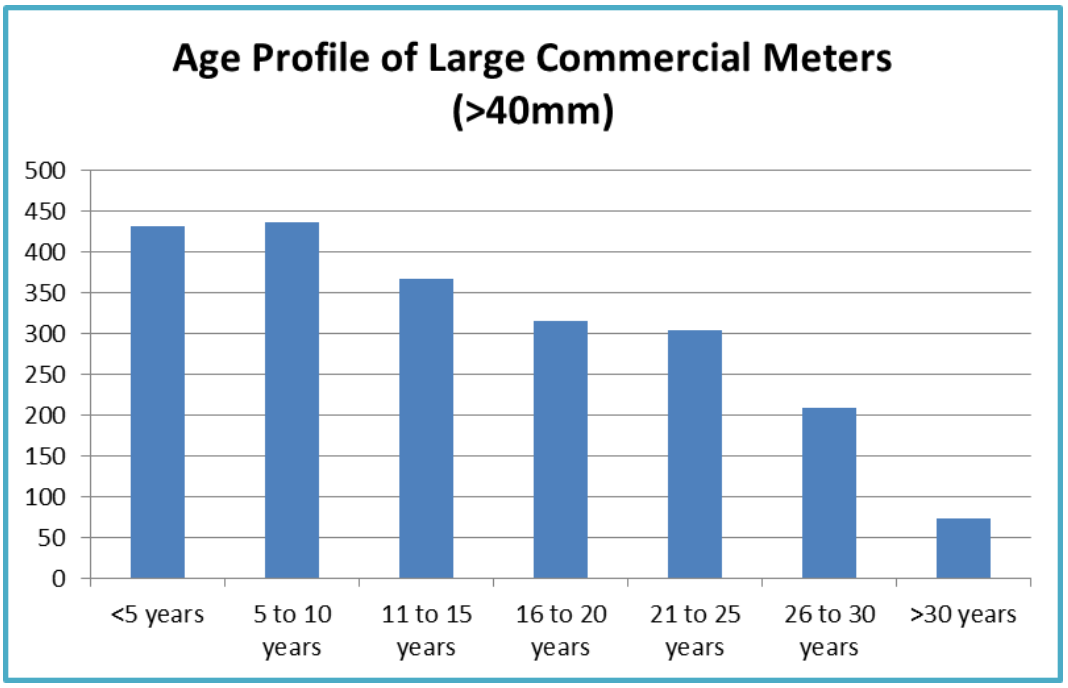
The Monson audit in September 2013 reviewed the meter replacement strategy in the South Staffs region and concurred with the Company's view that any short term savings resulting from a move to a reactive only replacement strategy would be quickly outweighed by a larger reduction in Company income.

The report summarised that the work planned for AMP6 could not be delayed past 2020 without reducing annual income to the Company and increasing still further the cost of the replacement programme in future years.

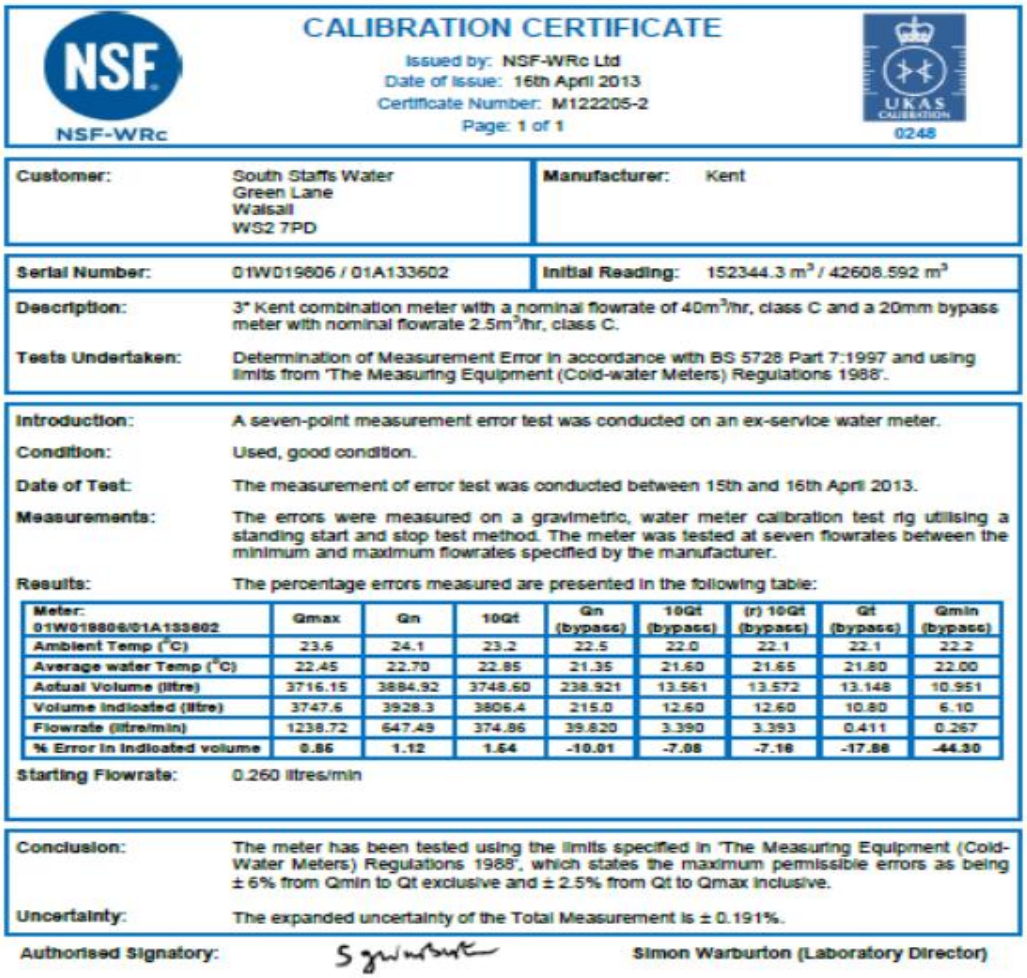
No challenges were raised by the auditor.

Non Household

This section refers to larger commercial meters, that are 40mm and above in size. The asset age profile is represented in the chart below:



The majority of these assets are mechanical meters that are the same types of meter as those installed on DMAs therefore the use of DMA test data, with a small number of additional tests on commercial meters has been used to model the deterioration of these assets over time in relation to meter under registration and loss of income. Meter testing has been carried out using UKAS accredited, independent meter testing facilities such as TUV NEL and WRc-NSF. An example of one of the meter test certificates is shown below:



CALIBRATION CERTIFICATE

Issued by: NSF-WRc Ltd
Date of Issue: 16th April 2013
Certificate Number: M122205-2
Page: 1 of 1

NSF-WRc

0248

Customer:	South Staffs Water Green Lane Walsall WS2 7PD	**Manufacturer:**	Kent
Serial Number:	01W019606 / 01A133602	**Initial Reading:**	152344.3 m^3 / 42606.592 m^3
Description:	3" Kent combination meter with a nominal flowrate of 40m^3/hr, class C and a 20mm bypass meter with nominal flowrate 2.5m^3/hr, class C.		
Tests Undertaken:	Determination of Measurement Error in accordance with BS 5728 Part 7:1997 and using limits from 'The Measuring Equipment (Cold-water Meters) Regulations 1988'.		

Introduction: A seven-point measurement error test was conducted on an ex-service water meter.

Condition: Used, good condition.

Date of Test: The measurement of error test was conducted between 15th and 16th April 2013.

Measurements: The errors were measured on a gravimetric, water meter calibration test rig utilising a standing start and stop test method. The meter was tested at seven flowrates between the minimum and maximum flowrates specified by the manufacturer.

Results: The percentage errors measured are presented in the following table:

Meter: 01W019606/01A133602	Qmax	Qn	10Qt	Qn (bypass)	10Qt (bypass)	(r) 10Qt (bypass)	Qt (bypass)	Qmin (bypass)
Ambient Temp (°C)	23.6	24.1	23.2	22.5	22.0	22.1	22.1	22.2
Average water Temp (°C)	22.45	22.70	22.85	21.35	21.60	21.65	21.80	22.00
Actual Volume (litre)	3716.15	3884.92	3748.60	238.921	13.561	13.572	13.148	10.951
Volume Indicated (litre)	3747.6	3928.3	3806.4	215.0	12.60	12.60	10.80	6.10
Flowrate (litre/min)	1238.72	647.49	374.86	39.820	3.390	3.393	0.411	0.267
% Error in Indicated volume	0.86	1.12	1.64	-10.01	-7.08	-7.16	-17.86	-44.30

Starting Flowrate: 0.260 litres/min

Conclusion: The meter has been tested using the limits specified in 'The Measuring Equipment (Cold-Water Meters) Regulations 1988', which states the maximum permissible errors as being ± 6% from Qmin to Qt exclusive and ± 2.5% from Qt to Qmax inclusive.

Uncertainty: The expanded uncertainty of the Total Measurement is ± 0.191%.

Authorised Signatory: **Simon Warburton (Laboratory Director)**

The reported expanded uncertainty for the meter error determination tests is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty has been carried out in accordance with UKAS requirements.

This test report, which incorporates calibration data, is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratory. This test report may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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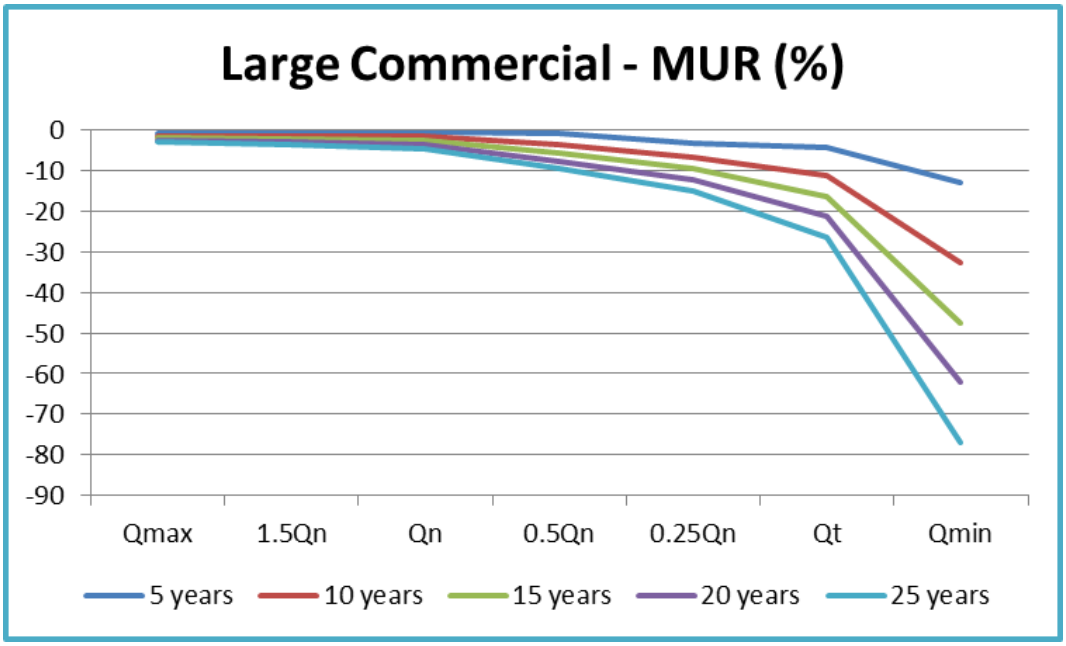
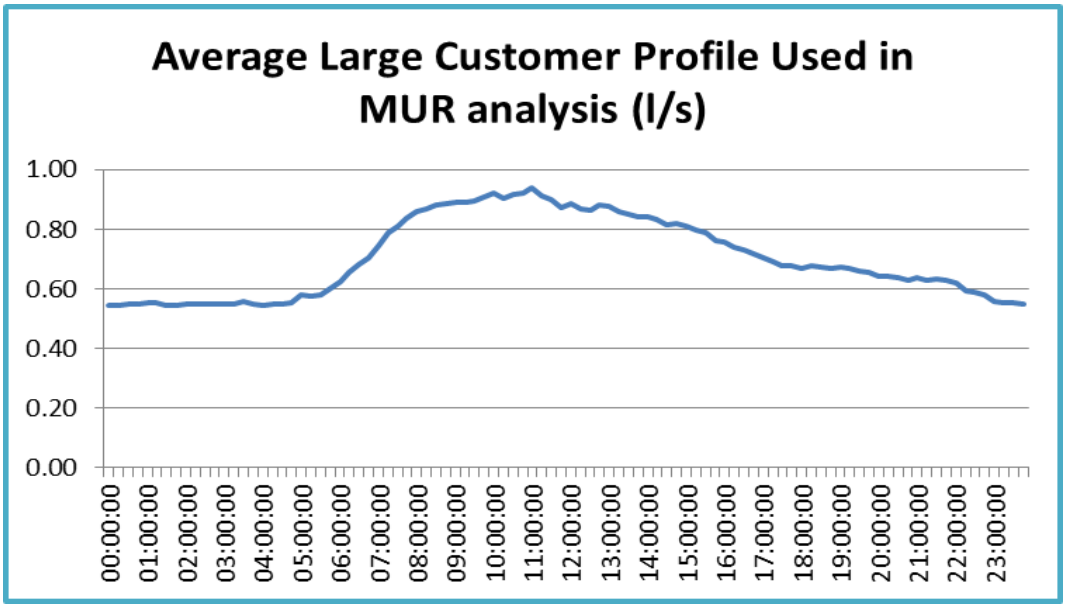
Telephone: +44 (0) 1495 236260, Facsimile: +44 (0) 1495 242499, E-mail: nsfwrc@nsf.org, Website: www.nsfwrc.org

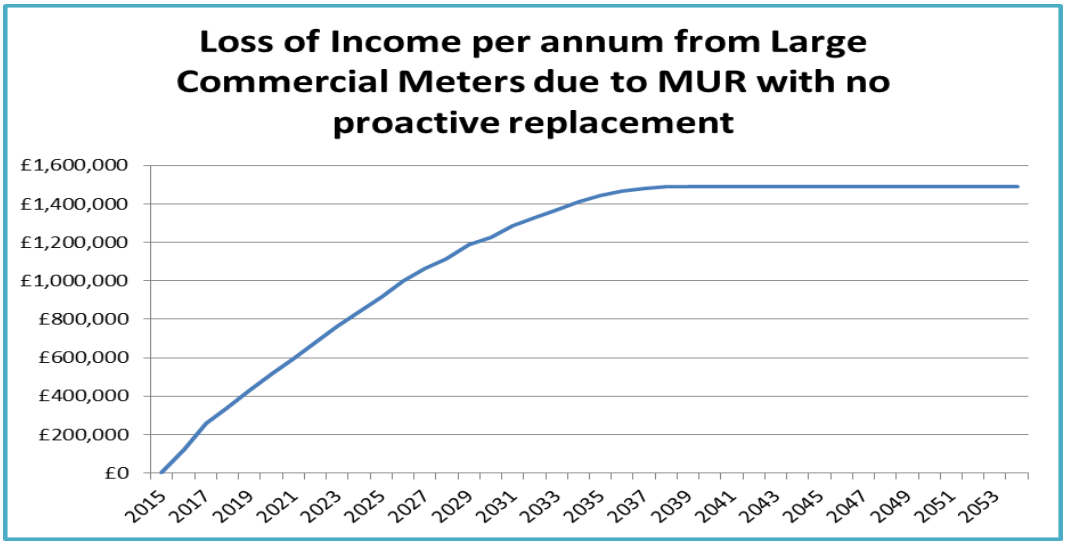
In order to assess the impact over time, test data was used to derive a profile of meter under registration with age based on data collected in AMP4 and AMP5.



An average flow profile was derived from a random sample of large commercial users, as shown in the chart below. This was used in conjunction with the age of the meter over time and the percentage of meter under registration at different flow rates, along with the average billed volume from 2012/13 to assess the potential loss of income over time without proactive meter replacement.



The following chart presents the loss of income over time relative to the current position, without a proactive meter replacement programme to maintain or improve the current asset stock.



Notwithstanding the need to prevent further deterioration, there is already an ageing asset stock with some meters that require replacement to reduce the average age of these assets. The most economical solution is to reduce the average age of commercial meters to around 10 years old and maintain this over the longer term, from a current average age of 16 years.

This scheme is comprised of delivery of the following in AMP6:

Item	Number (AMP6)	Cost (AMP6)
Replacement of meters in existing chamber arrangement	1817	£1,362,750
Full rebuild of chamber to standard specification including new meter	100	£837,252
TOTAL	1917	£2,200,002

Failing meters can result in estimated bills which can led to customer contact from billing and consumption queries. The benefit of this proposed investment is having a younger meter which is reliable, accurate and less likely to cause queries relating to costs and consumption.

Moreover the replacement of commercial assets provides two additional benefits to the customer. Firstly replacing the meter provides the opportunity to 'right size' the asset, downgrading the meter size based on the commercial site's water facilities and usage will reduce annual standing charges. Secondly, up-to-date meters will have capacity for data logging, this will enable the customer to obtain granulated consumption, flow and pressure data with minimal intervention if required.

A number of existing meters are not installed to The Company's standard specification that could lead to issues associated with meter accuracy if there is a technical challenge from a customer. A number of installations have heavy lids that are not standard, or are located in areas that are difficult to access. There are health and safety benefits associated with this proposed investment in reducing the risk of personal injury through lifting non-standard chamber lids.

Examples of non-specification meter lids / chambers posing Health & Safety concerns.

Historical Service Delivery

	AMP5				AMP6		
Activity	South Staffs	Cambridge	Total		South Staffs	Cambridge	Total
Free Meter Fits	29,179	5,553	34,732		29,150	3,999	33,149
Free Meter Options Expenditure	£7,240,791	£1,197,000	£8,437,791		£7,190,000	£796,000	£7,986,000
Change of Occupier Meter Fits	9,083	n/a	9,083		9,800	n/a	9,800
Change of Occupier Meter Expenditure	£2,188,319	n/a	£2,188,319		£2, 690,000	n/a	£2, 690,000
Household & Non Household Meter Replacements	27,957	5,586	33,543		36,917	13,000	49,917
Household & Non Household Meter Replacements Expenditure	£4,222,506	£780,000	£5,002,506		£5,060,002	£1,995,000	£7,055,002
New Development CPs	11,551	7,275	18,826		7,000	8,301	15,301
New Development CPs Expenditure	£6,404,063	£3,092,000	£9,496,063		£5,150,000	£3,528,000	£8,678,000

South Staffs Water

incorporating

CAMBRIDGE WATER COMPANY

Water Quality

Investment Strategy

December 2013

Introduction

Excellent water quality (now and in the future)

The Company is facing increased risks over both a short term and long term period. The following pages contain proposals for a mixture of solutions to control, or understand how to control, any increasing and existing risks. The measures proposed are a combination of engineering solutions, which will provide effective mitigation against the risks once constructed, and investigation approaches, whose impact will be over a longer term.

Due to the geographical separation of the two regions and the different raw water catchments and aquifers, the water quality concerns are specific to each area. Therefore the following pages are separated into region-specific schemes.

It is important to note that all of the following schemes have been supported or commended for support by the DWI: The following table summarises the support mechanisms the DWI have used for each scheme, on the condition that the Company responds to the caveats highlighted in the support letters (see Water Quality appendices for further details).

Scheme	Scheme reference	Legal instrument
Churchill WTW - Nitrate	SST046	Notice under Regulation 28 (4)
Fowlmere WTW - Nitrate	CAM045	Notice under Regulation 28 (4)
Chilcote WTW - Lead	SST047	Notice under Regulation 28 (4)
Lead Strategy	SST049	Regulation 28 Notice
Catchment Management – Hampton Loade and Seedy Mill water treatment works – pesticides, including Metaldehyde.	SST048	Undertaking under S19
Disinfection Bi-products	SST050	Commended for support

South Staffs Region

Churchill P.S. – Nitrate Scheme

Excellent water quality (now and in the future)

Secure and reliable supplies (now and in the future)

Hazard identification and risk characterisation

Churchill P.S. has a rising nitrate trend associated with historic usage of nitrate-based fertiliser within its catchment for agricultural purposes. Trend data from 2000 to 2012 for Churchill pumped water can be seen in Figure 1.

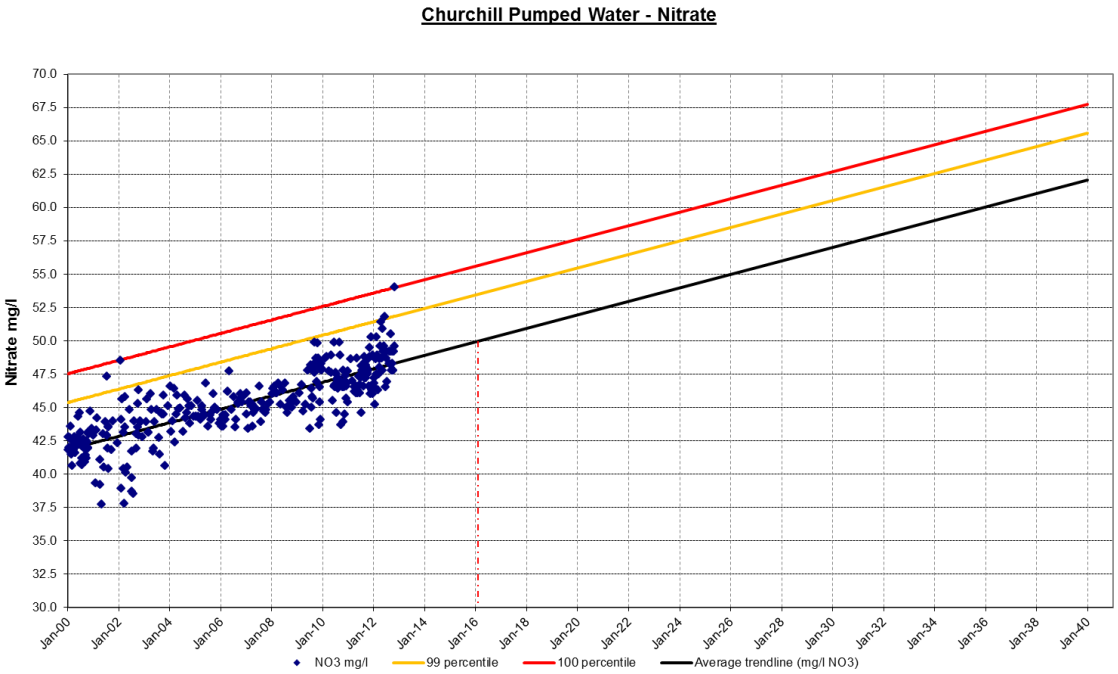


Figure 1, Churchill PS raw water nitrate concentrations.

Although the average level of nitrate from the source remains below 50 mg/l, peaks in nitrate have exceeded the Permitted Concentration or Value (PCV) as described in the Water Supply (Water Quality) Regulations 2000 for the final water. Figure 1 demonstrates that average levels are expected to reach 50 mg/l by January 2016 and increasing to c. 52 mg/l by March 2020. Peak results (based on 99th percentile calculations) are forecast to be above 55mg/l by the end of AMP6.

Churchill pumps water to Hayley Green reservoir and Hayley Green water quality zone (WQZ). The water supplied to these two points combines with small quantities of water supplied from other sites prior to reaching its supply point.

Figure 2 and Figure 3 show the nitrate trends at Hayley Green reservoir and Hayley Green WQZ. Nitrate levels in the reservoir have a 2012 average of around 45 mg/l reflecting the influence of Churchill with a degree of blend water. However, higher results have also been recorded reflecting water that is predominantly from Churchill with limited mixing with other lower nitrate sources. A result exceeding the PCV was recorded at the reservoir in October 2012 and consequently Churchill PS was

removed from supply to prevent further breaches. No breaches of the PCV have been recorded in samples collected from customer taps in the Hayley Green Zone.

A temporary short term blend has been introduced with increased water being supplied from Hampton Loade T.W., to ensure there is adequate supply to Hayley Green Zone. Continuing this arrangement would ultimately lead to the shutdown and abandonment of Churchill as a compliant blend could no longer be sustained via a blending arrangement.

The Company's estimate of deployable output and draft Water Resources Management Plan includes the long-term availability of output from Churchill. The loss of a 10 Ml/d source would require a review of the supply/demand position and would increase the risk of not being able to meet peak or drought demands. A review of the decision not to replace the Shavers End reservoir in AMP7, due to its age and condition, would also be needed as this decision was influenced by Churchill being available. There would also be an increased reliance on the output of the Cookley/Kinver blend via the Shaver's End supply zone, which also carries a risk from increasing nitrate trends and potential need for future reduction to source outputs.

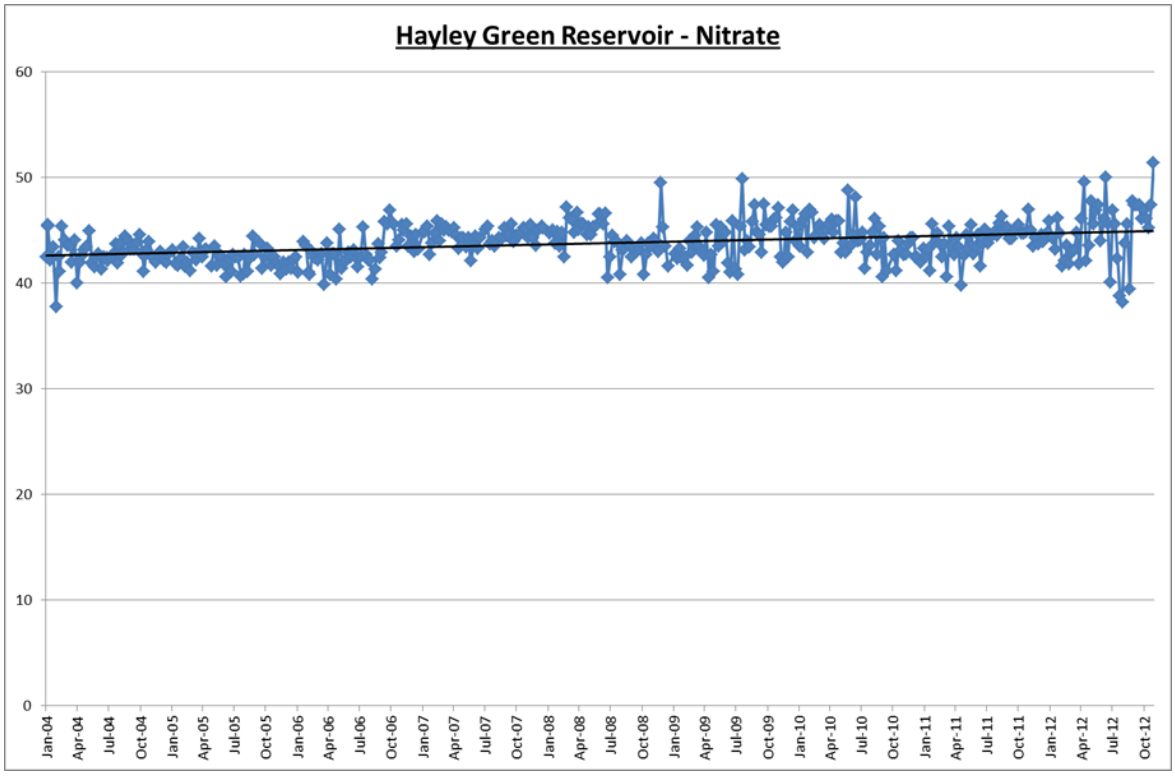


Figure 2, Nitrate sample results at Hayley Green Reservoir.

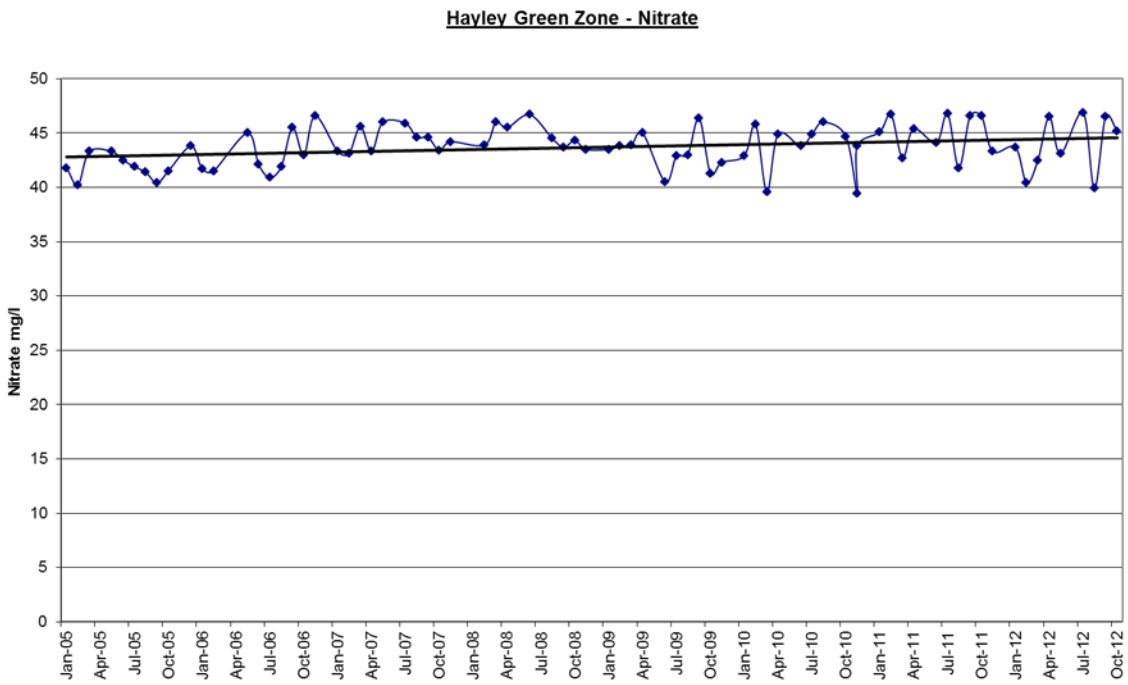


Figure 3, Nitrate sample results in Hayley Green WQZ.

Mitigation methods considered

The Company has considered a number of options to address the predicted rising nitrate levels at Churchill. The summary of these options are outlined below.

Option	Benefits	Limitations
Do nothing	Low cost	Churchill would need to be decommissioned in the near future as it would no longer be possible to supply compliant water; increased risk of inability to maintain supply to customers
Replacement source	If Churchill is abandoned, a new source could enable Company to maintain deployable output; could ensure current high nitrate levels are mitigated.	Uncertainty of outcome due to: • ability to have licence granted (over licensed and abstracted - EA) • new source yield • new source nitrate concentrations • costs
Install nitrate treatment at Churchill	Certainty of supplying compliant water	Large capital expenditure and on-going operating costs
Construct blend main	Certainty of supplying compliant water	Medium capital expenditure
Catchment management investigations	Low cost	Investigations – therefore uncertain results and uncertain timescale

Costs

Option 1: Do Nothing

There are no/minimal CAPEX and OPEX costs associated with this option.

Option 2: Replacement Source

The total estimated cost of developing a new source is between £3m and £5m.

Option 3: Nitrate Treatment Plant

CAPEX for installation of a nitrate treatment plant with an asset life of 25 years is estimated to be c £2m. Additional OPEX costs are a minimum of £110k per year.

Option 4: Blend Main

The total CAPEX cost of this option has been estimated at £1.2m, with additional OPEX costs of around £55K per year.

Option 5: Catchment Management Investigations

The cost of investigations is approximately £14k over 2 years.

Option(s) selected

In order to ensure resilience of supplies it is necessary to retain the output of Churchill. The alternative to replace the resource at another location is highly uncertain in terms of yield, quality and abstraction licence. These options also have high associated costs that are again highly uncertain. For these reasons, options 1 and 2 have been discounted.

The uncertainty of the timescale for success, or even whether success is attainable, for option 5 is the reason why it is not proposed as the sole option to mitigate the nitrate risks.

Therefore, as Churchill needs to be maintained, it is necessary to install nitrate treatment or to operate a secure blending scheme. The capital cost of nitrate treatment would be in the region of £2m and Opex costs would increase significantly. The blending option offers a number of advantages over treatment, including lower Capex and Opex costs, certainty of outcome and sustainability of the solution. Therefore it has been concluded that the blending main is the preferred option (schematic demonstrating proposed main can be seen in Figure 4).

In addition to the blending scheme, further investigations are deemed necessary to ascertain if catchment management is likely to be effective in reducing the concentration of nitrate in the Churchill catchment.

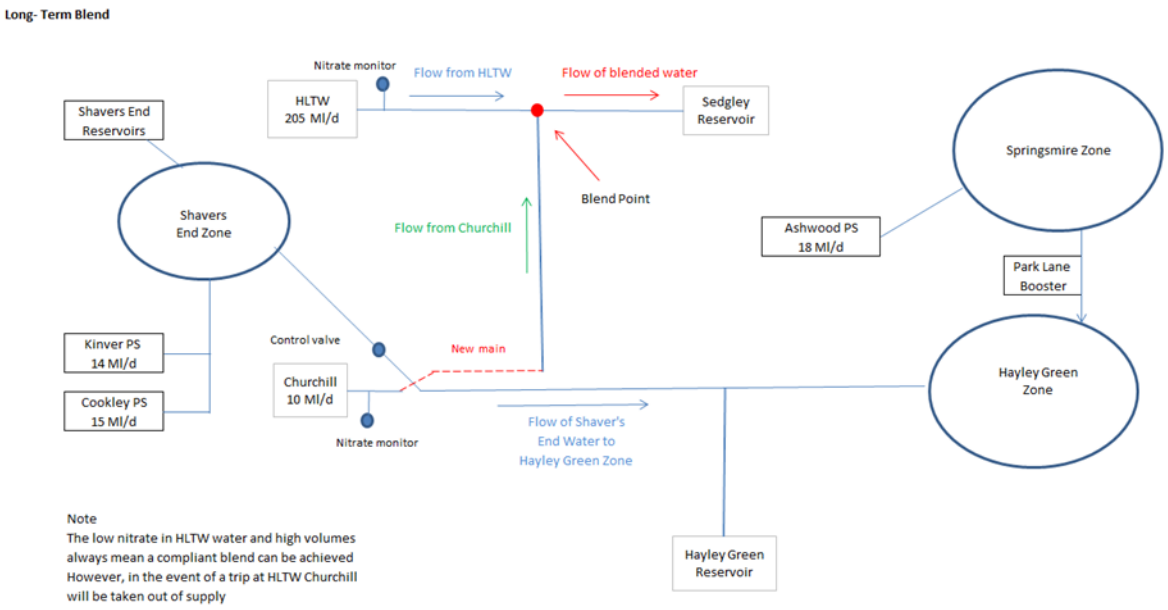


Figure 4, Schematic representing the construction of a new mains for blending.

Phosphoric Acid Dosing (Chilcote P.S.) and Prioritised Service Pipe Rehabilitation

Excellent water quality (now and in the future)

Hazard identification and risk characterisation

Chilcote P.S. supplies water to the Winshill Water Quality Zone (WQZ).. The original lead rig tests in the 1980s did not identify the source as plumbosolvent with the criteria existing at that time. Within the current plumbosolvency strategy the control measure requires regular sampling from random properties. It is via these samples that the source water has been identified as plumbosolvent following the impending reduction of the EC standard from 25 to 10 µg/l in December 2013.

By assessing the sample results from 2012, it can be seen that there has been one operational sample (30/8/12 at 31 µg/l) which failed the current standard (25 µg/l). There were 8 samples at consumers' taps which fail the new standard (10 µg/l). The Winshill WQZ will continue to be 'likely to fail' the new standard. Figure 5 shows historic sample results at consumers' taps in Winshill WQZ.

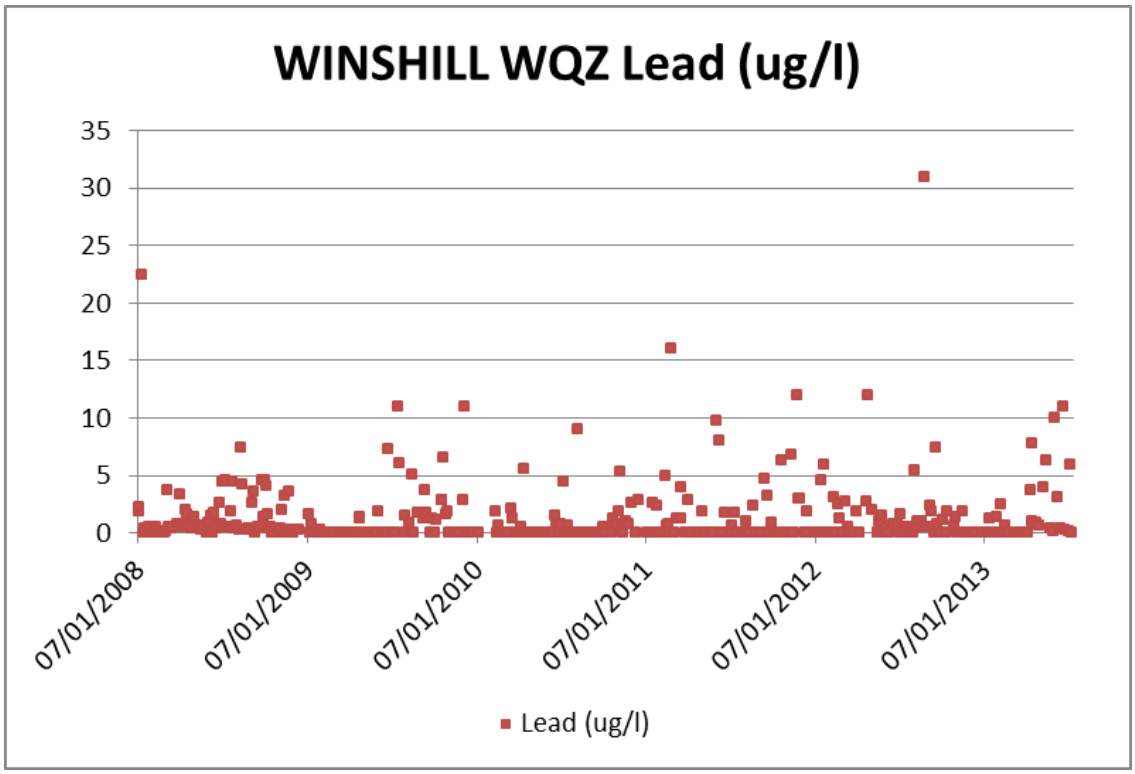


Figure 5, Graph showing historic sample results in Winshill WQZ.

Mitigation Methods considered

Given the nature of the occurrence of lead in drinking water an integrated package of measures is required to mitigate this risk. The following activities already exist to control lead levels in the supply system:

- Phosphoric acid dosing at all other water quality zones.
- Plumbosolvency control measures.
- Replacement of lead communication pipes upon compliance failure.
- Replacement of lead communication pipes when customers replace their supply pipe.

- Opportunistic lead communication pipe replacement.
- Working with health professionals in developing a Public Relations strategy to make customers and other stakeholders aware of the risk of lead in tap water; any mitigation; and who has responsibility for lead pipes.

Clearly, from sample results, despite the current package of work that exists, lead levels are higher than the PCV and therefore a residual risk still exists.

Option	Benefits	Limitations
Do nothing	Low cost	Increased compliance failure rate
Install phosphoric acid dosing at Chilcote PS	Improve lead concentrations at consumers' taps	
Full service pipe replacements for vulnerable groups	Improved lead levels for vulnerable groups	Uncertain results

Costs

Option 1: Do nothing

There are no immediate costs for this option. There is an elevated level of risk that the DWI will take enforcement action for continuing to have high levels of lead in distribution.

Option 2: Install phosphoric acid dosing at Chilcote PS

The additional costs to install a phosphoric acid dosing plant at Chilcote PS will be £69.3k capital cost with additional annual Opex of £14.1k.

Option 3: Full service pipe replacement for vulnerable groups

The operating costs of replacing lead service pipes (eg, communications pipe and private supply pipe) for vulnerable groups are approximately £100k per annum.

Option(s) selected

The Company are aware that the current approach for mitigating non-compliant levels of lead at consumers' taps is not successful. Therefore, it is proposed that a phosphoric acid dosing plant is commissioned at Chilcote PS.

It is well known that phosphoric acid dosing does not reduce the risk of high lead at all consumers' taps due to the nature of the pipework. Therefore the company also propose a policy of replacing the full service pipe at vulnerable groups' properties upon the failure of a lead sample.

HLTW & SMTW – Disinfection Bi-products

Excellent water quality (now and in the future)

Hazard identification and risk characterisation

THMs are readily formed in water supplied by Hampton Loade and Seedy Mill T.W.'s respectively, due to the presence of precursor substances, such as organic carbon, and the application of chlorine through the treatment process. The concentration in pumped water and in distribution varies but is generally in the range 20 to 50 µg/l. Higher peaks are seen, particularly in distribution during the summer months, with results occasionally exceeding 80µg/l. Large variations occur due to a number of factors including raw water quality, travel time and temperature with the highest THM levels recorded during the warmer summer months.

Currently there are no regulatory contraventions of disinfection bi-products (DBPs). However, THM levels in some zones fed by Seedy Mill and Hampton Loade have exceeded the screening criterion of an annual average of less than 50 µg/l used by the Drinking Water Inspectorate (DWI) as a broad indicator that, generally, a company is minimising DBPs effectively. Companies with results above that level are expected to be working towards achieving lower levels.

Mitigation methods considered

The Company have employed a number of operational practices which either minimise the formation of DBPs or remove/reduce their precursors (see Water Quality appendices for further details).

In addition to the work that currently occurs the only option the Company have considered is to perform a range of investigations to fully assess the potential for further minimisation of DBPs at the Company's surface water treatment works. An assessment has already been undertaken to identify potential areas of investigation and these are detailed in the Water Quality appendices. Where the Company does not currently have the necessary internal expertise consultants will be used to undertake reviews and advise on appropriate actions where possible.

Where low or minimal cost improvements are identified further benefits will be delivered by implementation of changes to treatment controls, system operation etc.

Costs

Delivery of the package of investigations identified above has been estimated at £180k.

Option(s) selected

Water Quality Zones within the South Staffs Water supply area have been highlighted as exceeding the annual average trigger level of 50 µg/l THMs used to assess compliance with Regulation 26(1A)(a). A number of control measures to minimise DBPs are already employed, however, the Company believe further investigation is required to ascertain if additional controls or changes to modes of operation can be implemented to further minimise the concentration of DBP.

The preferred solution is to investigate the potential for reducing DBP formation further, which will identify whether any additional action is needed to comply with the Regulation. Where no or low cost improvements are identified these will be

implemented within the period of the scheme. Other improvements requiring more significant investment will be considered for implementation as part of longer term strategies.

HLTW & SMTW - Metaldehyde

Excellent water quality (now and in the future)

Hazard Identification and Risk Characterisation

Metaldehyde is regularly found in the water supplied from Hampton Loade and Seedy Mill Treatment Works above the compliance limit. The Company have an existing undertaking for AMP5 to investigate and perform catchment management measures in the catchments for the two treatment works. To date, there has been some success in managing levels of metaldehyde, but the elevated levels still occur.

Mitigation Methods considered

The Company have undertaken a number of measures to date (see Water Quality appendices for further details).Due to the compliance position in autumn/winter 2012/13 further catchment measures are required to ensure compliance with the PCV. Existing measures need to continue. However, additional actions are also required:

- Engage EA to explore the possibility of sharing their website page “What’s in my back yard?” to ensure farmers/advisors are aware of the impact they can have on drinking water protected areas.
- Use of “hotspot” data to target farmers in areas with highest impact.
- Development of Water Safeguard Zone Action Plans for zones identified.
- Explore with Metaldehyde Steering Group the potential for product substitution.
- Development of statutory metaldehyde “label” requirements – currently only guideline maximums.
- Explore with NFU/agricultural industry alternative cultivation methods and/or wetland buffer zones

Costs

The scheme has been supported through the NEP programme under catchment management for AMP6. The costs for the NEP have been estimated at £500k over a 5 year period.

Option(s) selected

The Company propose to take the additional catchment management options listed above to further improve metaldehyde levels in the water supplied to its customers.

Catchment Management – Nitrates

Excellent water quality (now and in the future)

Fair customer bills and fair investor returns

Hazard Identification and Risk Characterisation

The aquifers that South Staffs Water abstract water from are experiencing trends of increasing nitrate concentrations. Historically, in order to mitigate providing water to customers above the level of compliance, South Staffs have used engineering solutions including nitrate removal plants and distribution network blending.

Without further investigation, it is expected that nitrate levels in the aquifers will continue to rise beyond the lifetime of the nitrate removal plants. Therefore, future nitrate levels may be dealt with more cost effectively now than mitigating them in future years with engineering solutions.

Mitigation Methods considered

There are two options to control future nitrate levels prior to distributing them to customers.

Option	Benefits	Limitations
Do nothing	Low cost during AMP6	Very high whole life costs due to future engineering solutions
Catchment management investigations	Low cost now and in long term	Investigations only therefore uncertainty of feasibility.

Costs

Option 1: Do nothing

The cost incurred during AMP6 will be £0. There is likelihood that once the existing nitrate treatment plants reach the end of their lives, they will have to be replaced.

Option 2: Catchment management:

The scheme was supported through the NEP programme under catchment management. The costs for the NEP have been estimated at £215k over the first 3 years of AMP6.

Option(s) selected

The company have decided to perform catchment management investigations to understand the feasibility along with the costs and benefits of performing catchment management in their catchments that have deteriorating nitrate concentrations.

Cambridge Region

Catchment Management and Nitrate Removal Plant at Fowlmere

Excellent water quality (now and in the future)

Fair customer bills and fair investor returns

Hazard Identification and Risk Characterisation

Nitrate levels in the groundwaters of Heydon Supply Zone have been increasing historically. This is constraining the Company as to how it currently operates its network. It is also leading to potential scenarios in AMP6 where the Company would not be confident that it could supply water to customers below the PCV for nitrate. Fowlmere PS feeds Heydon Zone along with Heydon PS, Great Chishill PS, and Morden Grange PS under normal operating conditions.

In November 2012 the Company received a Notice for Croydon PS from DWI under Regulation 28(4). This resulted in the Company disconnecting Croydon PS from the network. Consequently, Croydon Zone, which was fed solely by Croydon PS, was rezoned so it was fed off Heydon Zone. This extra demand from Heydon Zone was initially supplied from the existing sites. Once the winter recharge occurred, nitrate levels at all of the sites within the zone began rising. As a result, the Company rezoned Duxford Grange, which is a low nitrate source, away from Cambridge Zone and into Heydon Zone. This arrangement has continued until the present day.

Of the sites that supply the zone under normal operation, Morden Grange had an Undertaking for deteriorating nitrate levels during AMP5. The Undertaking resulted in the Company installing three boosters within the zone. The nitrates in the source water for Morden Grange are very responsive to recharge events and the resultant high nitrate peaks were modelled to last for up to six weeks at a time. During these peaks, which are forecast to occur once an AMP, the Company will turn Morden Grange off, and the boosters are used to supply water to all customers in the zone at adequate pressures.

Average day peak week demands for the combined Heydon and Croydon Zones were modelled in combination with different sites being out of supply. If these demands occur and Morden Grange along with any other site in the zone is out of supply, there is a risk that the Company would be unable to supply compliant water to customers.

Mitigation Methods considered

The table below highlights all of the options that were considered by South Staffs Water (Cambridge Region) along with their costs, benefits and their limitations.

Option	Benefits	Limitations
Catchment management	Sustainable solution, low long term costs	Uncertainty of success, solution is not immediate
Continue with existing arrangement	Low cost	Uncertainty of ability to supply consistent, wholesome water to the whole of the Company during peak demand scenarios (Duxford Grange feeds Cambridge Zone, which feeds the rest of the Company)
Laying a main to create additional blending options	May reduce nitrate levels in Heydon and Croydon Zones through blending	High cost; not long-term solution due to long term increasing nitrate levels at Morden Grange; uncertainty of success due to levels of nitrate at Morden Grange
Replacement or additional source	May reduce nitrate levels in Heydon and Croydon Zones through blending	Uncertainty of outcome due to: • ability to have licence granted (over licensed and abstracted - EA) • new source yield • new source nitrate concentrations costs
Nitrate removal plant	Certainty of outcome; previous experience of constructing a nitrate plant; increase in water available for use	High cost
Refurbishment of Croydon WTW	Increase resilience to Croydon Zone	Volume from source not enough to resolve high blended levels of nitrate supplied to customers (see page **Error! Bookmark not defined.**); Croydon Zone customers exposed to poorer source waters.

Option	Benefits	Limitations
Bulk transfer	N/A	No resource available from neighbouring water company.

Costs

Option 1: Catchment management

The estimated capital costs of further investigation of catchment management are£125k.

Option 2: Continue existing arrangement

There would be no additional capital costs or net operating costs on top of current Company costs associated with this option.

Option 3: Laying a main to create additional blending options

The distance of the main would be approximately 15 km, crossing 3 main roads; this option would also require an upgrade to Morden Grange treatment works. The initial high-level cost is greater than £5 million. This cost did not include any estimates for compensation related to land, or any archaeology costs.

Option 4: Replacement or additional source

The costs for a new source based on cost estimates for borehole remediation work that South Staffs Water are currently planning for Slitting Mill and Fradley would include:

- Land purchase £50k
- Drilling costs £750k
- Building £500k
- M&E for new boreholes £650k

This is a total of £1.95m excluding costs associated with connecting the new site to the mains network, and a power supply.

Following construction, there would be operating costs associated with the production of water. These will not be additional operating costs as it is assumed that a replacement source for Fowlmere would have similar running costs to Fowlmere.

Option 5: Nitrate removal plant

The capital costs of a nitrate plant at Fowlmere will be approximately £2.1 million based on the costs of the nitrate plants the Company has constructed during AMP5. Operating costs will be approximately £38,000 per year.

Option 6: Refurbishment of Croydon WTW

The cost of refurbishing Croydon is estimated to be between £1 and £1.2 million.

Option 7: Bulk transfer

There is a cost associated with laying a new main from the Affinity Water network to the Cambridge region's network. This cost has not been calculated as the option is unfeasible as Affinity Water have no spare resource to provide water to Heydon Zone.

Option(s) selected

The Company's preferred option is to install a nitrate removal plant at Fowlmere to mitigate the risk of supplying non-compliant water during AMP6. There would be an expectation that in order to ensure nitrate concentrations in the water remain acceptable in the future, there is a need for long term investment in treatment as well as continuation of work to establish an alternative solution. The Company have been working with the Environment Agency regarding Safeguard Zones, and the Agency have agreed that improved CBA is an important next step in understanding whether catchment management is a suitable approach. Therefore catchment management is seen as an integral part of understanding the cost of a sustainable solution, and is the reason the Company intend to investigate it further.

Catchment Management

Excellent water quality (now and in the future)

Fair customer bills and fair investor returns

Hazard identification and risk characterisation

Many of the aquifers which are used in the Cambridge region have increasing nitrate concentrations. As a result, in AMP5 the Company received 4 Undertakings to mitigate the risk of supplying water to customers above the PCV for nitrate. Those Undertakings have resulted in solutions requiring ion exchange nitrate removal plants at 3 treatment works (Babraham, Euston, and Fleam Dyke 36) being constructed in AMP5. The final Undertaking resulted in a solution which required the site concerned, Morden Grange, to be switched off upon certain nitrate concentration trigger levels, and boosters to be used to pump water around the Water Supply Zone to ensure customers received compliant water at acceptable pressures.

The Company responded to the increasing raw water nitrate levels by employing Mott MacDonald to perform some modelling to assess the responsiveness of each of the Company's sources to catchment management. These studies gave an indication of the timescale over which the benefits from catchment measures could be seen for mitigating increases in nitrates in abstractions from the aquifer. They also did some high level cost benefit analysis for each of the sources.

Mitigation Methods considered

There are two options related to catchment management as a result of the studies and modelling performed by Mott MacDonald.

Option	Benefits	Limitations
Do nothing	Low cost during AMP6	Potentially high whole life costs due to future engineering solutions
Catchment management investigations	Sustainable solution, low long term costs	Uncertainty of success, solution is not immediate

Costs

Option 1: Do nothing

The cost incurred during AMP6 will be £0. There is a strong possibility that once the existing nitrate treatment plants reach the end of their lives, they will have to be replaced.

Option 2: Catchment management investigations

The previous work performed by Mott MacDonald produced very high level costs for performing catchment management. These further investigations would provide the Company with an improved understanding of realistic costs of catchment management.

Option(s) selected

The Company propose to do further catchment management investigations to be confident they have done everything possible to minimise the whole life cost of controlling increasing nitrate levels in the raw water.