ST Classification: OFFICIAL COMMERCIAL (CONFIDENTIAL)

Taking care of customers' supply pipes

Business case 04

Severn Trent
29 January 2021

WONDERFUL ON TAP

SEVERN TRENT

Contents

Executive summary

Every day, our customers trust us to deliver safe, clean drinking water to their taps. This is the most fundamental aspect of the services we provide and as such it is heavily regulated. The water company owns the water pipe up to the property boundary, which means the customer owns the last section of pipe. This can, and does, affect the quality of the water coming out of their tap.

There is an increasing body of evidence on the damaging effects of lead, particularly in children under six, who show increased behavioural problems and lower IQs and other health issues. In response to this evidence, regulations governing lead standards in many countries are being tightened, for example Canada reduced its lead standard from 10ug/l to 5ug/ in 2019 and the European Drinking Water Directive was amended in 2020 to reduce the lead standard from 10 ug/l to 5ug/l with effect from 2036.

Customers are often uninformed of the health risks that legacy lead supply pipes pose and unaware that they are also responsible for fixing leaks or bursts on their supply pipes. It is estimated that between a quarter and a third of all leakage occurs on supply pipes. This burden currently falls on customers and, as a result, often gets left unchecked.

Instead of waiting for the legislation to catch up with the science, we think there is an imperative to act sooner. Not just because of the health risks of lead and environmental and physical cost of leakage, but also in recognition of the huge affordability challenge facing customers. With data showing that around 40% of all households in the UK do not have the savings to fix a burst supply pipe or replace a lead pipe, a different approach is needed.

Our proposal offers the step change needed to tackle the inherent risks and inequality created by the current framework through the delivery of three large-scale trials to replace 30,000 customer supply pipes, at a total cost of £98m. These will deliver the following direct benefits:

- immediate benefit for up to 30,000 homes who will no longer be drinking water that has been in contact with lead – immediately and permanently removing the health risk that poses;
- driving down water demand by a million litres a day, through a combination of removing leaking customer pipes and installing water meters. It will also reveal robust estimates of the leakage on these pipes;
- providing a better understanding of customer drivers and behaviours that influence how willing they are to have their lead or leaking pipes replaced;
- creating over 240 jobs across our region, directly and indirectly across our supply chain and local plumbers and trade people, which can be mobilised quickly. This includes taking on apprentices and focussing on skills for the future;
- developing a blueprint for the longer-term aim of removing chemical dosing from our system, which is currently used to mitigate health risks.

This will provide much-needed insight into how to create a sustainable and lower-cost model that can be rolled out across our region and beyond. This is critical to improving the affordability of compliance, given the likely tightening of the lead standard and the ambitious sector wide target of reducing leakage by 50%. It will also help inform any future decisions about the transfer of ownership of customer supplies to water companies.

1. Need for investment

Despite the compelling reasons for supply pipe replacement – including protecting public health, securing water resources and tackling inequality – the current model is proving too slow to drive change at the pace needed. Because supply pipes on customers' properties are owned by customers, barriers such as cost and disruption play a significant role in slowing the replacement of lead or leaking supply pipes.

We propose a solution that will enable us to achieve strategic goals in two challenging areas that are emotive for customers – lead and leakage – while creating employment opportunities for local people and businesses, removing affordability worries from customers and improving the environment in the trial areas. With the cost of debt at a record low, and inflation well below the assumptions at PR19, we have the opportunity to invest at low cost and keep bills affordable. Given that the question is when and not if this investment is needed, we believe now is the right time to move forward, for the following reasons:

Customers want it – and vulnerable customers need it

The current pipe ownership model places the responsibility on customers for replacing legacy lead pipes, as well as dealing with leaks and bursts on supply pipes. This proposal will bring direct customer benefits in the form of safer drinking water, reduced risk of pipe replacement costs, and reduced disruption. It will benefit financially vulnerable customers, who may struggle to afford the costs of replacing their supply pipes and who are more likely to have lead supply pipes, by a greater proportion – tackling a driver of inequality and contributing to levelling-up.

Accelerating the achievement of Government priorities

The introduction of new lead standards is likely to be required by 2036. Given the long-term public health impact of lead, particularly for children, and that the current approach of phosphate dosing is unlikely to be sufficient to achieve the new standards, it is clear we need to think differently to find a more affordable solution. This case would also contribute to Government ambitions in terms of decreasing water demand – a key contributor to securing water supplies into the future – by reducing leakage and contributing to reducing water consumption.

Skills and jobs for the UK's Green Recovery

At a time when the UK is facing projected unemployment of up to 11%[1], the benefits of our proposal to the country's Green Recovery will be significant. We can deliver employment and skills benefits at a fast pace. Our investment proposals include: increasing the number of network technicians; increasing work for self-employed tradespeople; and creating apprenticeships to ensure we have the right skills for the future.

Sharing learning across the industry

The challenge we face is common to every water company but, as yet, there is no leading model. Our approach of trialling three different delivery models will provide the industry with greater insight as to how a rapid acceleration of replacement (that also delivers health and leakage benefits, and a better customer experience) can be delivered affordably.

[1] 'Economic and fiscal outlook.' OBR (November 2020). Figure relates to virus downside scenario.

1.1 Customer views and support

1.1.1 Customer feedback on our proposals

The challenges associated with supply pipes are not issues that customers generally raise unprompted. For many, they assume that responsibility for the pipes is part of the core service we provide. Many customers are shocked that lead pipes are still in place today and that their supply pipes could be leaking without any obvious visible signs.

We know that leakage consistently emerges as customers' top priority for improvement: they consider the amount of water currently lost though leakage to be unacceptably high. However, many customers are unaware that at least 25% of all leakage is on customer-owned pipes. This means that customers are not necessarily aware of the important role they play.

We have initiated conversations with customers about supply pipes and their expectations and views on our proposals. Details of our overall approach to customer engagement are provided in Annex 03 Customer Engagement. We have drawn on previous research[2] to help us identify the best way of tackling this difficult and emotive conversation with customers. We have carried out customer research through a variety of qualitative and quantitative methods, totalling 3773 customer interactions, to gather a broad range of views and to facilitate the in-depth conversations needed to understand and tackle this challenge. Figure 1 sets out the key questions we sought to answer through each phase of our research. Each phase is then described in more detail below.

Figure 1: Our in-depth research has given us a detailed understanding of customer views

Phase 1: c400 views from Tap Chat

- initial impression of our proposals

Phase 2: In depth conversations with 44 customers (on-line community)

- what are the big issues facing the country?
- what is our role?
- initial impressions of our proposals
- views on funding approach
- what are the principles we should apply when making investment decisions?

Phase 3: Deliberative research with c15 customers specifically on supply pipes

- what are the benefits?
- what are the disbenefits?
- how best should we engage customers?
- who should we prioiritise?

Phase 4: Online survey of 55 customers who have replaced their supply pipe

- what prompt you to replace your pipe?
- who did the work?
- what went well and what didn't?
- how could it be improved?

Phase 5: Quantitative survey on acceptability (over 2500 customers)

- is the package acceptable
- is the bill impact acceptable?
- which are the investment proposals are most important to you?

[2] Including CCW DJS Research 'Customer views on Water Supply Pipe transfer options' to gather views on the transfer of supply pipe ownership in Wales 2016, UKWIR Report 14/DW/04/15 'Customers' Lead Pipes – Understanding Reluctance to Change' 2013, and CCW Response to DEFRA's Consultation on the future management of private water supply pipes 2013

Phase 1: Initial views from Tap Chat customers

Discussions on Tap Chat about our proposal to trial taking on maintenance of supply pipes were positive. Customers are supportive of the health benefits for children of replacing lead pipes, and pleased to hear that we can reduce chemical treatment as lead pipes are removed. They also understood that this proposal offers the benefit of considerable post-pandemic job creation.

"I would 100% support a lead pipe replacement scheme as it will be long lasting planned maintenance measure with significant health benefits and could provide safe, outdoor working for some unemployed individuals" **Customer, Tap Chat**

The main concern arising from this proposal was perceived to be the potential cost. Customers were also worried about disruption to their lives while the work is carried out. They posted lots of questions and comments that showed they had not previously been aware of the details of ownership or risks associated with lead pipes. We noted these areas of confusion and drew on them to build the research material for our next phase.

Phase 2: Deliberative Research

Customers say they want to be involved in our decision making in the future, especially around decisions that could impact their local area or their water bill. However, they believe that technical decisions are best left to the experts. Customers devised a set of principles that they thought we should use in future decision making on investments. Key themes include ensuring decisions are sustainable and future proof, communicating about decisions made to customers clearly and honestly, and securing safe and affordable water for all.

Customers did not raise the issues associated with supply pipes spontaneously. However, when given information about our proposals they responded positively, seeing our package of Green Recovery projects as an intelligent response to the Government's and regulators' request. They understood the benefits to the economy, the environment and community health and wellbeing.

Phase 3: Online focus groups, deep-diving into our proposals

This qualitative research involved 15 customers living in homes built before 1970, so likely to have lead pipes. We targeted a mix of social and economic groups, split into either homeowner or renter groups. Our aim was to delve into some of the previous concerns that customers have raised. In particular, we wanted to understand customers' responses to learning that lead pipes are still part of the water system and support for our proposals to replace them. We also heard that their appetite to take action personally, or even accept help to take action, is extremely low. We wanted to explore this contradiction with customers to understand what action we could take to reverse it. The full report can be found in *Annex 03 Customer engagement*, and the key findings are set out in Figure 2:

Figure 2: Key findings from our deliberative research activity

1	There were low levels of awareness of lead supply pipes. For some, particularly those with children under 5, the potential health risk of these pipes is particularly concerning. However, others presume that a lack of awareness of and discourse on the issue suggests that the health risk is probably minimal.
2	Customers are supportive of the supply pipes scheme overall and see significant positive impacts on Severn Trent customers as a whole. However, concerns about the personal disruption and possible hidden costs of the scheme mean that many are unsure if they would personally engage with it.
3	However, if a significant number of neighbours were having this work completed then many felt this might prompt them to take part themselves. These customers say that as the work being done in their area would cause them disruption anyway, they might as well experience the benefits of the scheme.
4	All customers also want clear communication from Severn Trent about the type and length of disruption that might be expected in order to feel confident participating in the scheme.
5	Adding £1 to every customer bill was felt to be the most appropriate funding option. Customers wanted Severn Trent to trial the scheme by area, prioritising the most vulnerable in each location.

When discussing the benefits, customers focused on three key areas as shown in Figure 3. They also raised disruption and cost as potential areas of concern as shown in Figure 4.

Figure 3: Our deliberative research showed how customers perceive the benefits of our proposals

Health and safety

- The clearest general benefit for the community was improving the health of all Severn Trent's customers with lead-free water. Some renters went as far as to link this to taking pressure off the NHS.
- Standardising the quality of supply pipes to reduce leaks was also hoped to benefit customers' safety and protect customer properties.

"it would help with health issues"
(JAM homeowner)

Saving water and costs

- Reducing water lost to leakage was appreciated to both save customers money and to ensure efficient use of natural resources, having a positive impact on the environment.
- Some financially comfortable homeowners thought that by ensuring water quality through pipes in the future, Severn Trent could save on treatment costs at the source, passing these savings onto customers.

"Water is scarce, always worried if paying too much…not on meter"
(JAM homeowner)

Creating jobs

- Customers in all groups also anticipated that delivering on this work would create much-needed jobs in their local areas.
- In particular, customers wanted Severn Trent to use this as an opportunity to implement apprenticeship and training schemes to up-skill younger people.

"I like the creation of jobs and apprenticeships. It could reduce their stat for leakage by having more people working on it."
(Renter)

Figure 4: The activity also enabled us to listen to and record customer concerns

Community disruption

- Customers were concerned that carrying out these works at scale would cause significant disruption and traffic. This was especially frustrating if they suspected they wouldn't directly benefit.
- Some were also concerned that the works could lead to bigger issues being made or discovered.

"I'm concerned that doing the work and digging up the road could lead to a bigger issue."
(JAM homeowner)

Costs and value for money

- While personal cost was a more prominent concern, there were questions over how the scheme as a whole would be funded.
- Among those who were not especially concerned about the impact of lead pipes, they questioned if it would be worth the money invested by Severn Trent.

"Obviously after you find a leak you try to fix it, but you need to balance it with the cost. Because if it's a tiny tiny leak then you might not even realise it for the next 10 years."
(Financially comfortable homeowner)

Homeowner's responsibility

- A minority of financially comfortable homeowners felt that the issue was the homeowner's own responsibility, so questioned whether Severn Trent and other customers should be involved in paying for the work done.

"I don't see why you can spend hundreds of thousands on a house but not spend £800 on a pipe if it's a problem."
(Financially comfortable homeowner)

We then asked customers what personal levers would encourage or prevent them from taking action. The results are set out in Table 1.

Table 1: Factors that would encourage or prevent customers from taking action

Encourage action	Prevent action
Having an understanding of the health impacts	Perception that disruption would create stress and add problems to their busy lives
Knowing that work is done by a trusted employee and avoids surprise bills/cost – provides peace of mind	Concerns about the cost
Awareness that the work will increase house value or improve the chances of a house sale	For those renting, concerns about relationships and responsibilities of landlords
If neighbours were also taking action	Not seen as a priority for them

We also tested different funding options. The majority of customers supported having a flat rate (notionally £1 - £2) on bills to make the replacement service free. This was a clear preference amongst less well-off customers. However, some financially comfortable customers thought that only those benefiting should have to pay.

Finally, we sought views on how best to prioritise any action. We asked customers to select between:

- Prioritising those most at risk of the health impacts (i.e. those with children under 6);
- Prioritising customers who would most struggle to afford the replacement; or
- Where water scarcity is a bigger issue and could be helped by reducing leakage on customer pipes.

Initially customers opted for the first option (prioritising on health impact). However, customers identified additional benefits of rolling out trials by area. They felt that that this would:

- Minimise disruption by doing multiple works at once.
- Give customers assurance through 'safety in numbers'.
- Provide cost savings through economies of scale.
- Give the potential for chemical treatment to be phased out in areas now free from lead.

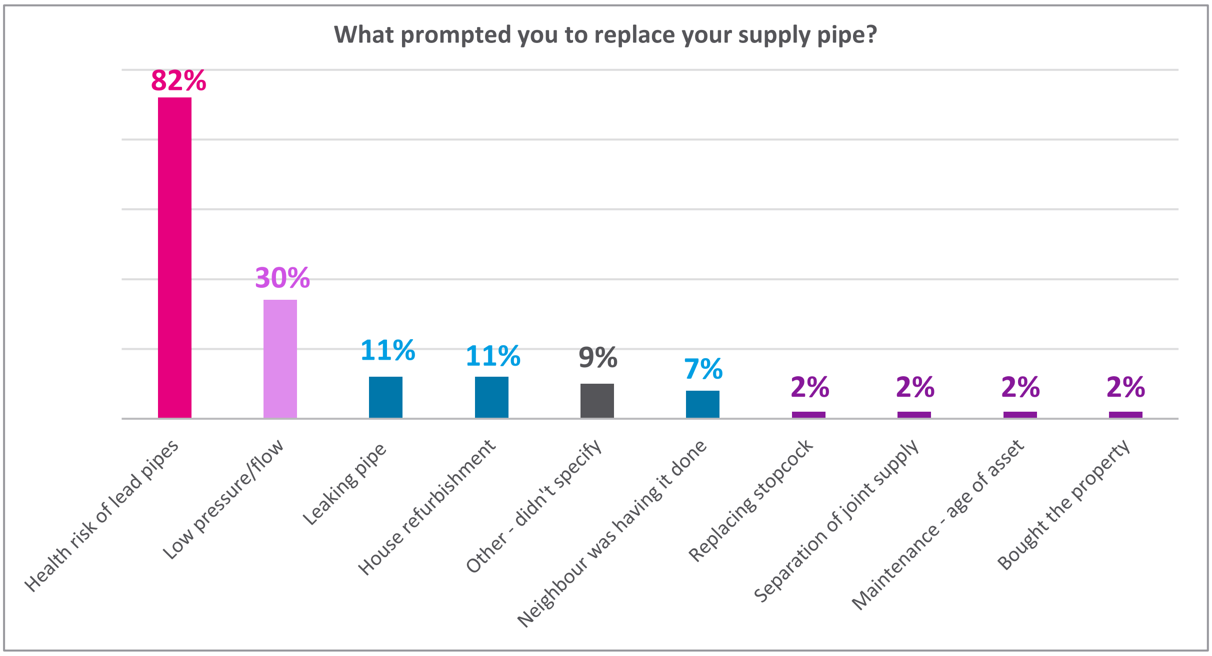
Phase 4: survey of customers with personal experience

We sent surveys out to over 400 customers who have had their supply pipe replaced in 2020. 55 customers replied in response to the following questions:

- What prompted them to replace their pipes?
- Who carried out the work? Who do you think should do the work?
- What went well and what went less well?
- What could have been done to improve the experience?

The majority (82%) of customers took action because of health concerns for themselves and their family associated with lead pipes. The other reasons are shown in Figure 5:

Figure 5: Results from customer survey on reasons for undertaking supply pipe replacement

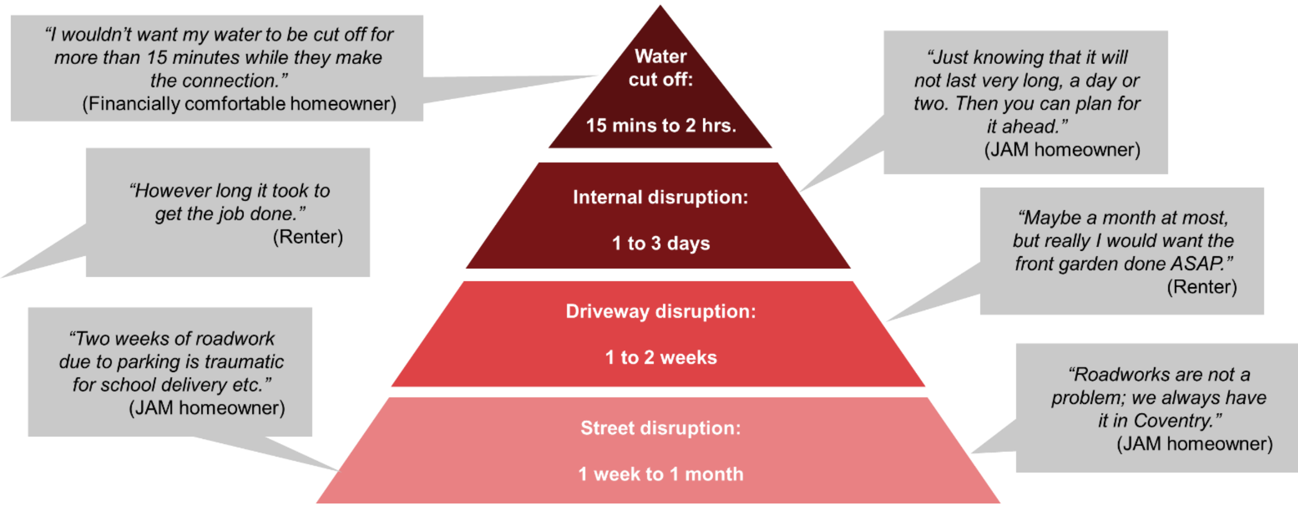


Note: customers were able to select more than one reason

Customers used a mixture of approaches for replacing the pipe. The most common were through water safe plumbers (44%), undertaking the work themselves (22%), local plumbers (13%) and through a contractor doing a larger home improvement project (14%). When asked who they thought should have done the work, 71% thought the pipes should be replaced by Severn Trent.

When exploring positive and negative parts of the experience, the quality of the workmanship and peace of mind once it was complete were the most cited positives. There were also some unanticipated perceived benefits, such as improved taste to the water, and some customers noted improved water pressure as an overall benefit than had said it was a factor in their decision to replace their supply pipe. The lowest rated aspects were the time taken to replace the pipe and the disruption it caused. This aligned with the views customers shared in the phase 3 research, who also cited disruption as a main barrier. When we asked how the experience could have been improved, there was unanimous consensus that good communication and minimising disruption are key. Figure 6 shows the different levels of disruption customers find acceptable for different stages of the work.

Figure 6: we gathered customer feedback on different levels of disruption



Phase 5: Quantitative views on acceptability

Based on the survey results of 2,138 household customers and 399 non-household customers, we see that there is strong support from our customers for the schemes we are proposing in our Green Recovery business plans. We found that 83% of household customers support our package of four Green Recovery projects, before being shown the bill implications, with only 2% being unsupportive. More detail about the approach and results is included in Annex 03 Customer Engagement.

Support for this supply pipes proposal is high, with 82% of household customers supporting it, 2% unsupportive and 16% saying they either do not know or do not mind.

1.1.2 Helping the financially vulnerable

The current pipe ownership model places the responsibility on customers for replacing legacy lead pipes, as well as for dealing with leaks and bursts on supply pipes. Costs for proactively replacing lead supply pipes are typically £1,000-£1,500, but can be higher as they depend on factors such as the length of the supply pipe. Insurance cover for burst or leaking pipes may be included in some home insurance policies. However, many customers do not have insurance cover for issues with supply pipes. Without insurance, the cost may be up to £5,000 to deal with an emergency; more if there is building damage.

This places a particular financial burden on customers in lower socio-economic groups. Department for Work and Pensions data from 2019 shows that approximately 13 million households (48% of all UK households) have either no savings or less than £1,500 in savings[3]. The East Midlands region has the third highest proportion of customers with savings of under £1,000 (35%), after the North East and North West[4]. This means that around half of households we serve may struggle to pay for lead pipe replacement themselves and are vulnerable to emergencies such as burst pipes. The impacts of Covid-19 have been particularly acute on lower socio-economic groups, making these affordability challenges even more pressing. People on lower incomes are, therefore, less likely to proactively replace lead pipes and less likely to move house which means this group of customers face a disproportionately higher level of risk. This shows there is a need to consider financial vulnerability. As described in section 1.1.1, our customers support the idea of prioritising efforts to support other customers who might struggle to pay to replace their own pipe.

1.2 Accelerating the achievement of Government priorities

The current model of ownership of and responsibility for supply pipes means that key barriers (such as cost and disruption for customers) are preventing the achievement of shared societal priorities such as removing lead from drinking water, protecting water supplies in the long term, and supporting financially vulnerable customers. Through our innovative approach to customer supply pipes we will drive positive change in these areas, contributing to many Government priorities.

1.2.1 Safeguarding the health of future generations

Independent health advice indicates that there is no safe standard for lead in drinking water[5]. For example, young people exposed to lead in drinking water, even at the current 10ug/l legal standard,

[3] https://themoneycharity.org.uk/media/Feb-2019-Money-Statistics.pdf
[4] https://www.raisin.co.uk/newsroom/articles/better-saving-money/
[5] World Health Organization (WHO) Lead Fact Sheet, 2019 – https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

show increased behavioural problems and lower IQs[6]. Toxicological evidence reported by Public Health England[7] also noted that there could be subgroups of children with increased susceptibility to lead, such as those living in areas of high social deprivation.

The most significant contribution to lead levels at the customer tap, where the standard for lead is measured, is often the supply pipe within the boundary of a customer's property[8]. Across the UK, more than half of customer properties are at risk of having supply pipes made of lead (approximately 63% of properties were built prior to lead pipe being banned in the UK by 1970)[9]. In 2013, it was estimated that c36% of UK properties still had lead pipes in an UKWIR report[10]. In the Severn Trent region, an estimate of greater than 770,000 lead supply pipes (around 22%) was produced by Atkins in 2017[11]. This was based on analysis of the age of properties, sample results and extrapolation of small scale pipe material verification trials.

The policy direction for lead standards in drinking water reflects the growing consensus that lead is a public health concern. Unlike any other drinking water parameter, the standard for lead has already been tightened twice over the last 20 years: from 50ug/l in 1990, to 25ug/l in 2004, and down to 10ug/l in 2013. A tighter standard of 5ug/l has been set in the revised Drinking Water Directive, and UK legislation is currently under review. We anticipate the timeframe to be similar to the European policy that the UK helped to influence –which requires European compliance with effect from 2036, giving a 15-year lead time for changes to be phased in.

We see a clear opportunity to move to the best long-term solution ahead of drinking water legislation. The large-scale trials outlined in this proposal will reveal valuable insights into how we can move at pace towards the lead-free vision, informing imminent policy and helping us to make better sector-wider decisions at PR24.

1.2.2 Tackling phosphates to protect the environment

Phosphate dosing negatively affects river water quality. Between 2020-30, £2.5bn will be invested in wastewater treatment process upgrades for phosphorous removal. It runs contrary to the concept of a circular economy to rely on phosphate dosing at one end of the water cycle, while actively seeking to remove it at the other.

Phosphates are damaging to the environment, and water treatment processes contribute around 10% of the total phosphates in the environment in England. This percentage is increasing as a result in reductions made in other sectors, such as the 2015 ban on phosphates in domestic laundry products[12]. As a sector, we have concentrated our attention on enhanced treatment of phosphates through the

[6] World Health Organization (WHO) Lead in Drinking Water, 2011- https://www.who.int/water_sanitation_health/dwq/chemicals/lead.pdf
[7] Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment, 2008 - https://cot.food.gov.uk/sites/default/files/cot/cotstatementtds200808.pdf Reported by Public Health England (PHE) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/653725/Lead_toxicological_overview.pdf
[8] DWI, Guidance on the Implementation of the Water Supply (Water Quality) Regulations 2010 in Wales – http://dwi.defra.gov.uk/stakeholders/guidance-and-codes-of-practice/WS(WQ)%20Regulations%20Wales2010.pdf
[9] https://www.statista.com/statistics/292252/age-of-housing-dwellings-in-england-uk-by-tenuree/
[10] UKWIR Report 14/DW/04/15 'Customers' Lead Pipes – Understanding Reluctance to Change' 2013
[11] Atkins 2017 Communication and Supply Pipes (Severn Trent Water internal document)
[12] The Detergents Regulations 2010

wastewater treatment process. However, we need to work towards meeting the goals in the Government's 25 Year Environment Plan across all aspects of the value chain.

Chemical use is growing and adding to the carbon challenge. This means there is a growing need to make faster progress towards our long-term sustainable strategy of phosphate disengagement, using fewer chemicals in the treatment of drinking water to reduce environmental damage and minimise the carbon impact of our water supplies. If we were able to stop all phosphate dosing for lead risk mitigation across the whole company, then the carbon footprint associated with chemical use would reduce by approximately 8-9%.

1.2.3 Improving water resilience through demand-side reductions

The Government forecasts that 4,000Ml/d of new supply-demand capacity will be needed by 2050. To balance supply and demand, the 25 Year Environment Plan, and the more recent National Framework, have set ambitious targets to halve leakage and reduce Per Capita Consumption (PCC). To achieve these ambitions, we need to look more holistically at demand-side solutions to drive leakage reduction and PCC ambitions at an affordable cost.

Leakage reduction through supply pipe replacement

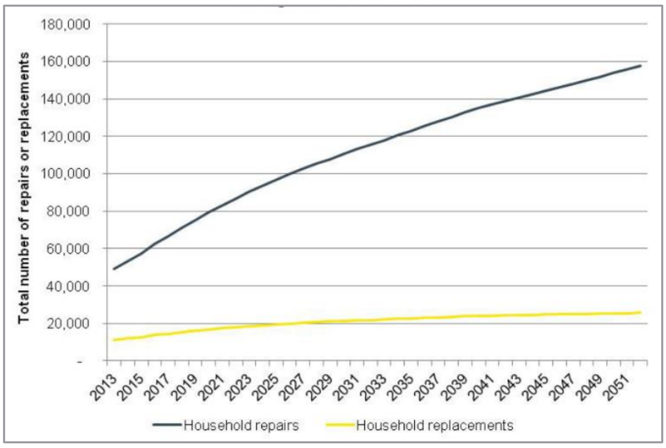
Reducing leakage will be key to closing the supply-demand gap. We are on track to reduce leakage by 15% over AMP7, and by 50% by 2045 (5 years earlier than the Industry target of 50% by 2050). Leakage reduction reduces network waste, saving water, treatment chemicals, production costs and carbon emissions from water treatment.

However, between a quarter and a third of leakage is outside our direct control as it occurs on supply pipes owned by customers, for which they have responsibility. Reducing leaks on customers' properties currently relies on the voluntary action of customers, or on water companies incentivising customer action once a leak is discovered or taking enforcement action. Joint supplies (where more than one property shares part of its supply pipe with its neighbouring properties) is another factor which presents a challenge to resolving customer side leakage, as this presents difficulties for detecting leaks, both in terms of pinpointing leaks and a reduced ability to monitor flow with water meters for these configurations. We have found that 90% of customers will repair a single supply leak without the need for enforcement action, in an average (median) of 32.6 days. This reduces to 67% when a customer is on a joint supply, with 37% requiring enforcement action. For the 67% where customers repair the joint supply, it takes on average 61.4 days, nearly double that of the time to repair single supplies. See Appendix 1 for more details on the challenges posed by joint supplies.

Supply pipes will need to be part of the solution to achieving leakage reduction (and lead reduction) goals. However, it also revealed that customers are confused about ownership and responsibility, and there are affordability issues around repairing and maintaining these pipes. Defra's supply pipe impact assessment[13] included forecast cumulative repair and replacement activity. This shows the number of repairs will have to increase significantly to address leakage.

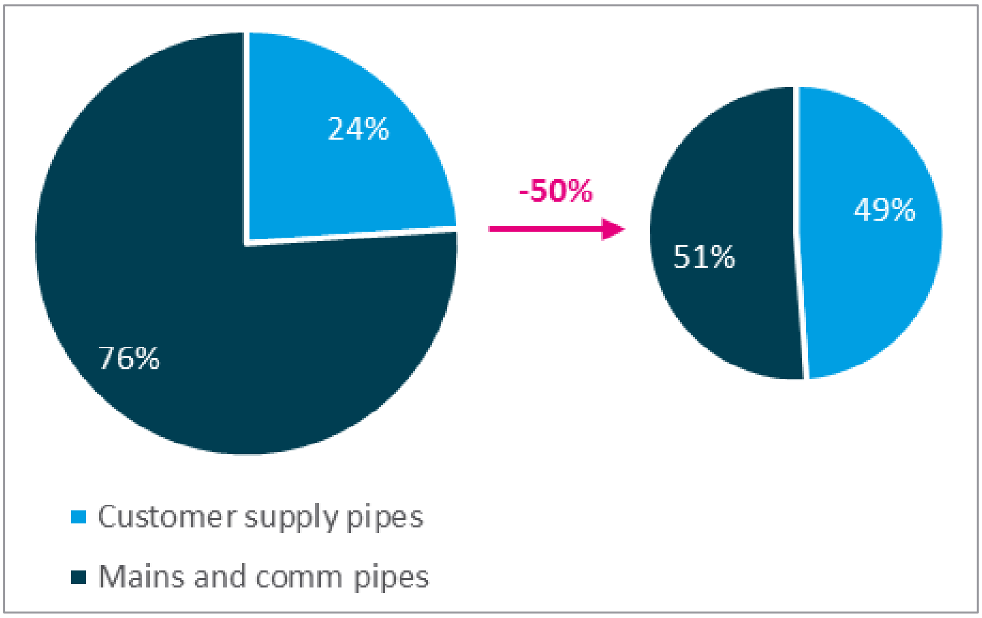
[13] DEFRA Impact Assessment for Transfer of private water supply pipes to Water and Sewerage Company ownership, 2013 https://www.gov.uk/government/publications/impact-assessment-opinion-private-water-supply-pipes

Figure 7: Projected number of household supply pipe repairs and replacement in England and Wales 2013-2052 (Defra, supply pipe consultation impact assessment)



Our plan to address customer-side leakage also aligns with Government priorities to ensure bills remain affordable. To meet the long-term reduction of 50% by 2045 without tackling customer pipes would increase costs by as much as £200m per AMP because it will get progressively harder and more expensive to find and fix leakage as the overall amount of leakage reduces. This means that from 2025 onwards all companies will have to significantly increase the amount of mains replacement. This is congruent with the action taken in countries with leading performance on leakage, such as in Tokyo (where leakage is 3.2%), where the average age of a water main is 20 years and the replacement rate is five times the UK average. If we were to continue to only focus on leakage across company-owned assets, by 2045 over half of all leakage would be occurring on customer-owned pipes as shown in figure 8.

Figure 8: Leakage from Severn Trent network and customer supply pipes and the anticipated proportional change to meet the 50% reduction by 2045 target



Accelerating metering to reduce water consumption and identify leaks

In 2018, the National Infrastructure commission recommended that, to meet future water scarcity challenges, companies would need to work with customers to get them to reduce their daily demand down to 118 litres per person per day by 2045.[14]

To meet this ambition we need having accurate data on each household's consumption. Meter penetration across our region is currently around 50%. We need to increase this rate if we are going to meet the long-term ambition. On average, measured customers use 10% less water than unmeasured customers; Southern Water, Thames and Affinity have seen an 8-16% reduction in demand through their large-scale metering rollout programmes, as well as a 10% reduction in peak demand. Having accurate consumption data means we are able to:

- Understand changing consumption patterns from any leakage breakout on our network, and deploy repair teams more quickly.
- Identify customer supply-side leaks and work with customers to repair them.
- Help customers use less water by working with them to change their behaviours or resolve internal plumbing issues.

1.3 Creating jobs and developing skills

The UK is facing projected unemployment, with Government forecasts predicting unemployment to rise to 2.6 million nationally by mid-2021[15]. Young people (18-24 years old) have been among the worst hit by the Covid-19 pandemic. The trials in our proposal lend themselves to apprenticeships and in-work training that are needed across the UK. We will deliver skills and employment benefits at a fast pace, mobilising Green Recovery benefits almost immediately as we create over 240 jobs and build a new technician and plumbing skills base in our region. See *Annex 05 Creating Jobs and improving skills* for more details on the employment-related benefits of this proposal.

1.4 Sharing learning across the industry

The challenge we face is common to every water company. As yet, there is no leading model, no standardised data sets or clear understanding of the costs and benefits. Our approach of trialling three different delivery models will provide insights that we can share with the industry to support a step change in the approach to pipe replacement (that also delivers health and leakage benefits) and a better customer experience that can be delivered affordably.

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[14] page 25 https://nic.org.uk/app/uploads/NIC-Preparing-for-a-Drier-Future-26-April-2018.pdf

[15] https://www.bbc.co.uk/news/uk-politics-55072987

2. Our long-term strategy for supply pipe replacement

Our vision is to balance future supply and demand for water, and build water resilience, in a way that improves biodiversity, reduces carbon and continually strives for **100% compliance with water quality standards**. We believe this can only be achieved if we are not constrained by the current model of responsibility. Our supply pipes proposals will enable us to gain better understanding of risk and where it is necessary for us to take action, allowing us to continue to protect everyone at an affordable cost. Our goals are to:

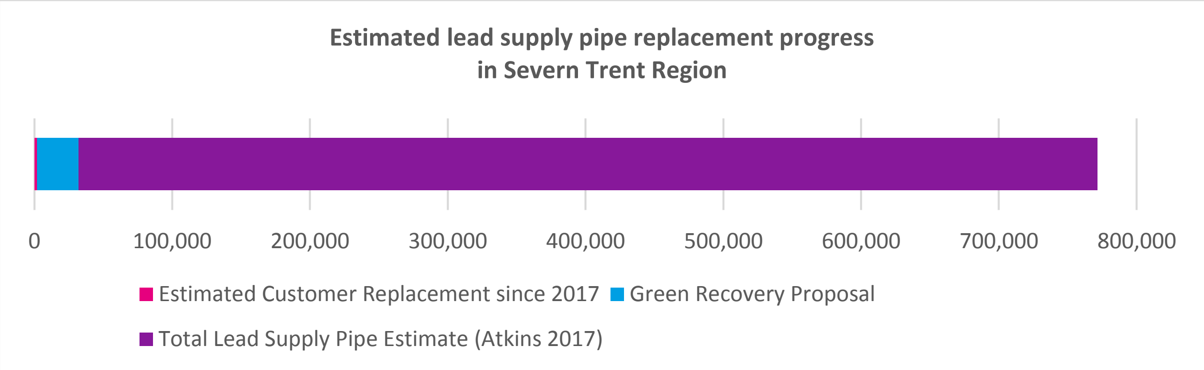
- Protect public health by removing lead pipes from the water supply network;
- Protect the environment by ending phosphate dosing and improving water resilience; and
- Find more affordable solutions for meeting our water demand-side reduction targets.

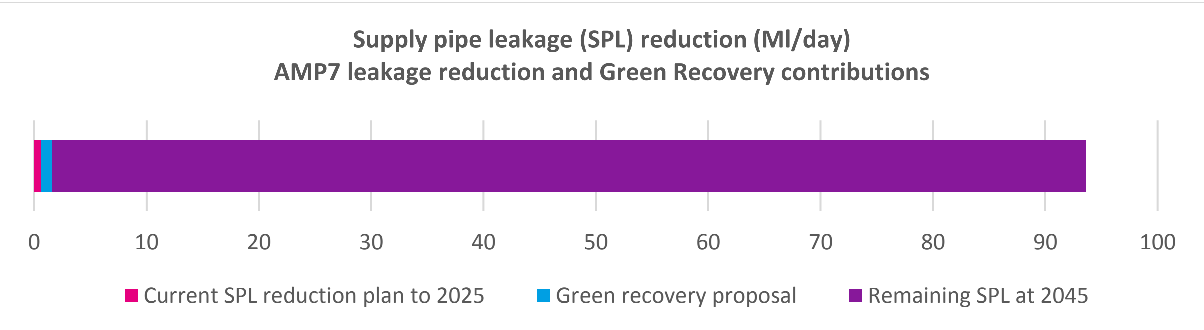
At present, we do not have all the information we need to identify the best way of achieving the long-term vision. Therefore, the aim of this proposal is two-fold:

- To reduce the number of lead and leaking pipes; and
- Gain insights that enable us to make better, bolder decisions at PR24.

Figure 9 shows that we are at the tip of the iceberg in terms of tackling both lead pipes and leakage and the aim of this proposal is to get more certainty on the size of the overall challenge and to drive down costs so that we can find more cost effective solutions to enable a faster pace to be achieved. Based on the timeline for tightening the standard across Europe is 15 years, it is a reasonable assumption that we would need to tackling the challenge at a much faster pace than proposed in this business case and therefore the 30,000 pipe replacements is clearly no-regrets AMP8 investment.

Figure 9: Our proposal is no regrets investment in the context of the overall challenge



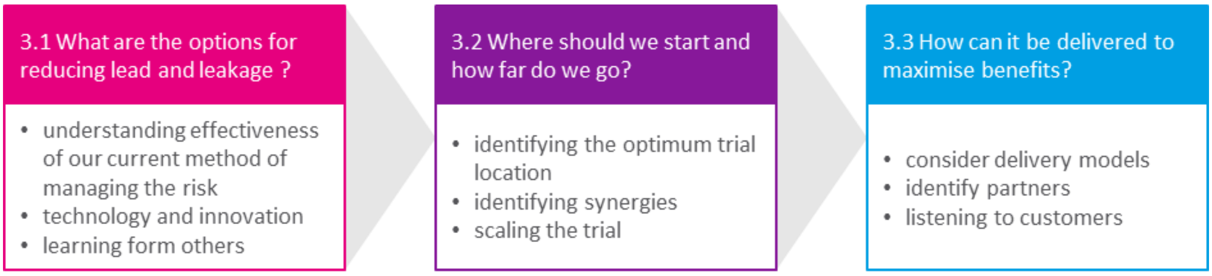


3. Best option for customers

Section 2 sets out our long-term vision and our view of the gap between the current situation and the future ambition, this section sets out the options that we have considered to find the best way to meet our customers' needs and, in doing so, maximise the benefits in support of the Green Recovery.

The options that we have considered to close this gap fall into three categories, as illustrated in Figure 10 and detailed in sections 3.1 to 3.3:

Figure 10: Our approach to identifying the best option for customers



We have developed a robust approach to assessing which of the options offer the greatest benefit (or protection) to customers. This is set out in section 3.4.

3.1 What are our options for reducing lead and leakage?

There are four high-level options available:

- Improve the effectiveness of the existing **treatment process**.
- Find and **replace** lead and/or leaking pipes.
- Find and **reline** pipes to both fix leaks and provide a (time limited) barrier between the lead pipe and drinking water.
- Find and **repair** leaking pipes.

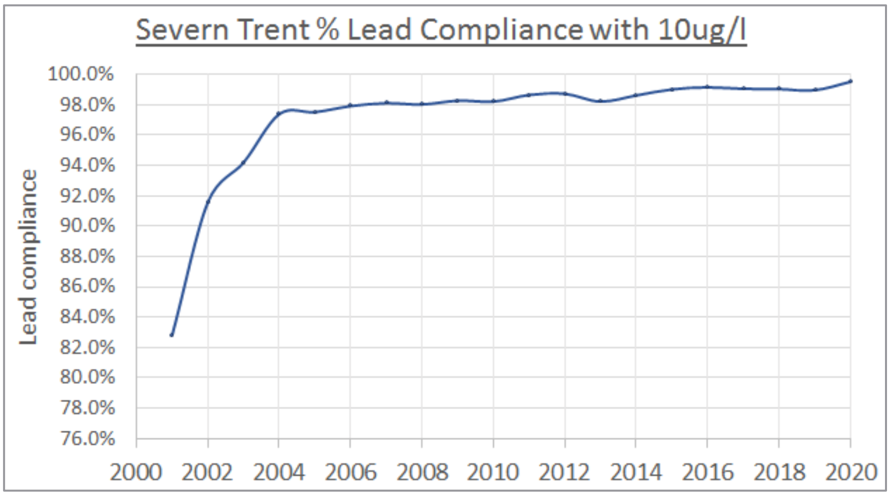
We have considered the options within these high-level approaches in turn.

3.1.1 Understand the effectiveness of current treatment process

We have first looked at our existing approach to see if it can be improved to meet the tighter lead standard or if we can improve our current approach to reduce customer-side leakage. Compliance with lead standards is largely achieved through phosphate dosing. Industry compliance with this standard is high, and it is an appropriate solution at the current legal standard. However, evidence shows that phosphate dosing alone will not achieve the tightened standards of the future.

While phosphate dosing significantly reduces lead risk, it does not prevent all lead failures. Phosphate chemistry is complex, and the industry is continuously improving the effectiveness of phosphate dosing. Figure 11 shows that compliance with the current lead standard of 10ug/l has significantly improved over the last 20 years and now stands at around 99%. However, for more than a decade, the industry compliance level has plateaued.

Figure 11: Severn Trent % lead compliance over time (all routine lead samples)



If we target a tighter lead standard without a change in approach, our current compliance will deteriorate. We anticipate on average three times more failures if the lead standard is lowered to 5ug/l. If the limit was 0ug/l, that jumps to more than 30 times more failures, as shown in Figure 12. Table 2 shows that sample non-compliance from the last few years would have increased from <1% at 10ug/l to 3% at 5ug/l and 30% at 0ug/l (below the limit of detection).

Figure 10: Number of Severn Trent regulatory samples that have breached 10ug/l (current limit) and 5ug/l (future limit) and any positive detection (0ug/l/no safe limit)

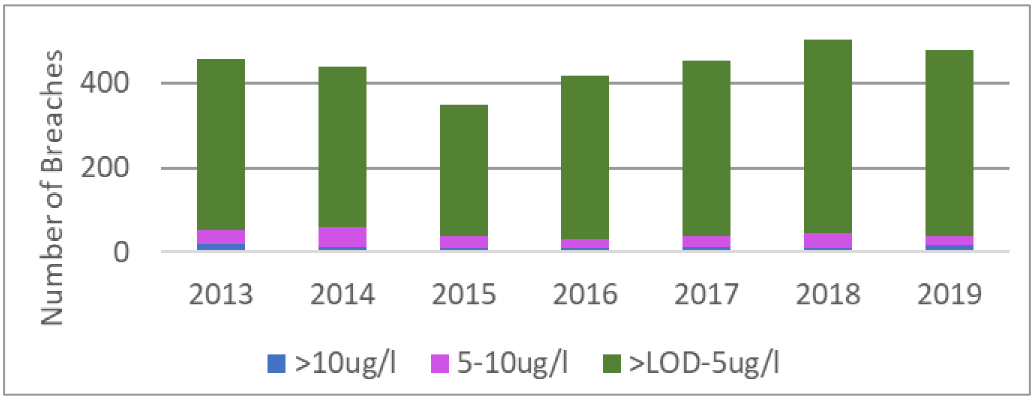


Table 2: Customers at risk at progressively tighter standards (sample non-compliance)

	% Customers at risk		
	10ug/l	5ug/l	0ug/l
2013	1.1%	3.3%	29.9%
2014	0.9%	3.7%	28.8%
2015	0.6%	2.5%	24.4%
2016	0.6%	2.1%	29.3%
2017	0.8%	2.7%	31.9%
2018	0.6%	3.0%	34.9%
2019	1.1%	2.5%	33.6%

Over 90% of customers are served by water that has been treated with phosphate to prevent lead from pipes and fittings from leaching into the water. The remaining 10% are deemed low risk.

However, it is widely acknowledged that chemical treatment would not be enough to prevent all lead failures at the tighter standard.

"It is extremely difficult to achieve a concentration below 10 μg/l by central conditioning, such as phosphate dosing." Lead in Drinking Water, WHO, 2011[16]

We conclude that using additional chemical treatment is not a viable option for meeting the future lead standard. It also has no benefit for customer-side leakage, so does not address wider supply pipe issues. As a result, we do not consider it to be an appropriate alternative investment option for this proposal.

3.1.2 Technology and innovation

There are two aspects of this challenge than can be addressed through technology and innovation; customer expectation and cost.

Customer expectation is one of the greatest challenges to overcome when replacing supply pipes. We appreciate that each one of our customers will have a different set of circumstances and reasons for embracing supply pipe renewal or rejecting it. Under our existing powers, we cannot force our customers to allow us to replace their private pipework. We will break down these barriers by utilising technology that reduces customer disruption and inconvenience – a key factor that emerged from the customer research set out in section 1.1.

There is also a cost challenge that can be overcome by using more advanced pipe replacement techniques. These techniques, such as pipe pulling and directional drilling, reduce the cost of reinstatement as well as the disruption to customers. These techniques may be more expensive to set up initially and have challenges (e.g. location of other utilities in the vicinity, suitable ground conditions), but provide cost efficiencies over a relatively short period.

We have identified options to use technology and innovation to minimise costs and disruption across three specific areas, described in detail below:

1. Identifying lead and leakage.
2. Replacing, repairing or relining pipes.
3. Better support for and engagement with customers.

1. Options for identifying lead and leakage

We currently face a major challenge, as we do not know which pipes are made of lead or which pipes are leaking. By improving our ability to identify these issues we will deliver substantial cost savings, which we will maximise by prioritising those works that will yield the most benefit.

Identifying lead

Traditionally, lead pipes are detected by taking water samples from customers' taps, or by direct inspection of pipework. The latter has usually involved inspection at any exposed pipework in the customers' property and digging trial holes to verify pipe material in the ground. Lead samples follow sampling protocol requirements ('first flush' or Random Daytime (RDT) sampling technique for regulatory samples), but has acknowledged inherent sampling repeatability and representative

[16] World Health Organization (WHO) Lead in Drinking Water, 2011 – https://www.who.int/water_sanitation_health/dwq/chemicals/lead.pdf

limitations, as it is depends on the time in contact with the lead pipe before sampling takes place. Less invasive methods that are reliable and produce results quickly are therefore sought after.

We have been working with the Knowledge Transfer Network to set up an innovation challenge, which will invite companies to pitch solutions that will allow us to:

- Determine the presence (or positively confirm the absence) of lead pipes in the customer supply pipe – detecting levels at or below 5ug/l.
- Produce a result in real time on site.
- Record and easily export data to our existing database of properties.

We published this challenge in January 2021[17], with the competition set to close in March 2021. We are also currently trialling a micro-camera which can inspect pipe material from the boundary box (as shown in figure 11 and 12), potentially negating the need for excavations to verify pipe material and further reducing customer inconvenience. The product is still in a developmental phase, and not currently able to confirm lead pipes, but we will be seeking to do further trials when this is available.

Case study – innovation – pipe micro-camera

We have done some early trials of a micro-camera which can inspect pipe material from the boundary box, potentially negating the need for excavations to verify pipe material, further reducing customer inconvenience.

Figure 11: Micro-camera being used to review service pipe

Figure 12: Micro-camera image on screen a 2 inch

Identifying leakage

This is not a new challenge nor specific to us. We are continually working to improve our approach in this area, reflected in our status as founder member of the World Innovation Fund.

Identifying leaks on any pipe relies on us being able to measure the flow along them. Traditionally customers' water meters were read on average every 6 months. High consumption triggers an investigation to search for a leak, but there is usually a significant time delay between the leak forming and the repair. Automatic Meter Reading (AMR) Meters can be read more regularly at less cost and used to target supply pipe leakage – these are being rolled out in our current AMP7 metering scheme. Technology developments in Smart Meters will deliver data on request which will in turn lead smaller

[17] KTN Innovation Exchange – https://www.ktninnovationexchange.co.uk/Challenges/Single/96

leaks being located faster. Smart Meters are planned for roll out in the Green Recovery Metering Proposal.

Once we have identified a leak on a supply pipe, the next challenge is to pin point the leak for repair, usually by excavating the buried pipe and replacing a small piece. The methods for pinpointing leaks mainly rely on tracing the acoustic noise the leak creates when it escapes from the pipe. We use a correlator and a device called the 'pipe mic' to listen to the leakage and pinpoint where along the pipe the leak is located. We are also exploring further advances on this technology.

Case study – innovation – pipe mic

The 'Pipe Mic' is a simple technology listening device with pin point accuracy. It works under pressure from Boundary Box to Property and from the Boundary Box to main.

It brings benefits due to its 'right first time' identification of leak position and reduction in excavation to the boundary. It reduces the time until repair, with fewer hand-offs for the customer journey for bursts and leaks on supply pipes and reduces travel time and traffic management.

2. Options for replacing, relining or repairing pipes

We will use technology and innovation to find a feasible and affordable solution for every supply pipe to be renewed. We believe that a 'one size fits all' approach will fail and that customers think that we should prioritise action based on risk, and not cost or complexity of the individual circumstances. We have considered technologies designed to replace small-diameter customer pipes. In reviewing the options we have considered three factors:

- **1. Desirability – does our customer want it?** We will assess benefits to the customer, and whether they outweigh the disruption. We will determine the path of the new pipe, the number and size of the excavations, duration of the work and any changes to the aesthetic of the house or garden.
- **2. Feasibility – can we do it?** We will determine the limiting factors of each techniques, the length of pipe, size of excavation, vicinity of known risks (i.e. other utilities), access to the site, ground conditions, and ascertain whether the outcome will be within a reasonable tolerance of the required quality standard.
- **3. Affordability – does it represent efficient costs?** We will evaluate whether the work can be achieved within the current view of efficient cost.

Replacement options

Scope – There is a consideration of how far the pipe should be replaced – i.e. to the wall of the property or to the internal stop tap of the property to represent the point of compliance (kitchen tap). If lead pipe is only replaced up to the wall of the property, a small portion will be left in place and will continue to leach some lead into the supply. Given there is no safe level of lead, the option to replace up to the internal stop tap is the desired outcome, despite the additional cost and disruption this would cause to replace this legacy pipe material – this is the option for replacement we have chosen in this proposal for all lead pipes. Although not published at the time of writing, the anticipated

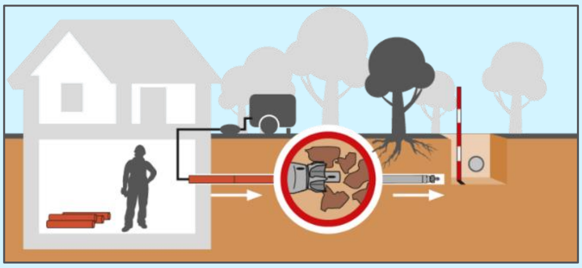
DWI/WRc research paper '*Long Term Strategies for Reducing Lead Exposure from Drinking Water*' is understood to support this option in terms of cost-benefit for lead pipe replacement.

Technique – We have identified six techniques for replacing pipes, shown in Figure 13, and will compare suitability for household supply pipe scenarios (as alternatives to open cut techniques). Some are tried and tested methods in the water industry, but not currently used widely at Severn Trent, and some are more novel techniques.

Figure 13: We will consider a variety of techniques for pipe replacement

1. Thrust boring ('moling')

The 'mole' first pushes through the ground before the new pipe is attached to the hose that drives it and is pulled through. This technique has been around for more than 20 years and is widely used in the sector.



2. Kobus pipe puller

The Kobus unit pulls the new pipe through by using the existing pipe that is in situ. The unit attaches the new communication pipe to the old pipe and a pulley system pulls it out while replacing with a new pipe. This technique has existed for over five years, and is used within the industry (not currently fully embedded at Severn Trent).

3. Vacuum excavation

This technique uses small, mobile vacuum excavation units that suck the earth from the ground. It is notably safer and faster than hand digging techniques. It can also be used in conjunction with Thrust Boring. It is not yet widely used in the water industry, but is established in Severn Trent.

4. Microtrenching

A narrow trench is created by circular saw cutting device, combined with vacuum excavation to clear the debris so a new pipe or cable can be laid in the trench. This reduces disruption and reinstatement costs associated with normal trenching technology. Not widely used in the sector, but is emerging as a potential opportunity.

5. Directional drilling	**6. ‘Core and vac’**
Similar to thrust boring, but has a nozzle and is a steerable solution. Useful in scenarios with obstructions where there is a need to go around objects. It is widely used in the sector for mains laying, but may need some adaptations for smaller pipes.	Innovative technology that cores a circular hole in the ground and is vacuumed out for micro works. Core is replaced after work is carried out to reduce reinstatement costs and impact. Can be used in conjunction with directional drilling. Cores can be overlapped (in a ‘figure of eight’) to increase size. Used for over two years in the gas sector, but not yet been taken up by the water industry.
	

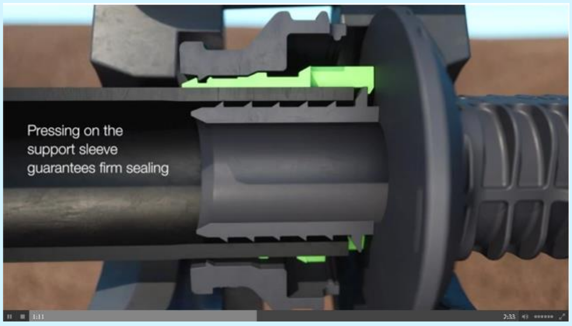
Regardless of which of the above replacement techniques we use, we need to ensure it is the best solution that is sustainable for the long term. This includes considering the balance and cost over time of different pipe materials to target the most sustainable and best long-term performance – minimising cost and future disruption for customers. We have recently collaborated with other water companies as part of an UKWIR research project into the longevity of polyethylene pipes[18]. The study defined a method for testing the oxidants within polyethylene pipes to determine remaining life expectancy.

From testing 30-year-old pipe samples, the project concluded that the life expectancy of a new polyethylene pipe is in excess of 150 years. Potential weak points such as pipe joints, can often be a cause of failure, rather than the structural integrity of the actual pipe. The challenge was to apply the learning from the polyethylene pipe research and extend it, to ensure the construction techniques used when installing pipes could match the longevity of the inherent pipe material. In January 2020 we commenced a small-scale Severn Trent trial of using press pipe fitting novel technology. Figure 14 and 15 provide more detail.

18 UKWIR Research Report – Long Term Aging of Polyethylene Pipes, 2020 - https://ukwir.org/long-term-aging-of-polyethylene-pipes

The Pressjaw clamps down on the fitting and the Pressgun applies pressure to tighten it. Pressing on the support sleeve then guarantees firm sealing.

Figure 14 – Pressjaw and Pressgun applying pressure Figure 15 – Tightening pressure on the support sleeve



Our trial concluded that the use of press fittings drive significant benefits;

- In built quality assurance (100% leak free joints)
- Minimum staff training (low level of skill required to install)
- Low cost installation (equipment and duration)

Relining options

In some cases it may be more appropriate to reline the pipe (e.g. where access is restricted, in circumstances where the ground is congested with many utility services or where the risk of breaking the ground is too great). Relining options offer a less disruptive option and can sometimes offer cost savings, although previous trials show that the cost differences are marginal and variable. It also does not remove legacy lead pipes, so this is a medium term solution rather than long term. It may be considered in exceptional cases, but is not the generally preferred option.

Repair options

Using traditional methods, repairing a pipe to reduce leakage is often only marginally cheaper than replacing it, and in some cases can be more expensive. This is because labour and reinstatement are typically the two highest cost components involved in both repairs and replacements.

However, if the leaking pipe is made from lead, the option of repairing the pipe does not address the water quality risk, so this would not be considered an appropriate solution. For non-lead leaking pipes though, there may be some situations where this may be a more cost-effective solution for addressing leakage than replacement, using more innovative techniques. Therefore, we have considered options for repairing leaking pipes that drive reductions in cost, disruption and increase the longevity of the repair, where this may be more cost-effective.

Figure 16: Case Study – Innovation – Seek-a-Leak Putty

Severn Trent are part of an Innovate UK Knowledge Transfer Partnership with Manchester Metropolitan University (MMU) to develop a leak-seeking patch, inserted into pipes without the need for excavations or removal of existing pipes, that can be used for a variety of different types of leak.

Delivered so far

- ✓ We have defined the properties needed to create a cost-effective putty capable of repairing leaks within smallest 10% and largest 10% of leaks on supply pipes.
- ✓ Capture all the technical specifications developed within the KTP into required tender documentation ready for Tender.
- ✓ We have developed and lab tested a product which repairs leaks from the inside of a small diameter pipe
- ✓ We have designed a process capable of repair 80% + of leaks on supply pipes
- ✓ We have designed and built the tooling and training material to rollout this repair technique
- ✓ Subject to water quality regulation being met and field trials proving successful we expect to rollout the process business wide in 2021.

3. Options for better supporting and engaging customers

Our customer engagement showed us that we need to find better ways to explain risks, and the actions we will take to mitigate those risks, to customers. We also need to improve the information and support we provide throughout the construction period. We identified further opportunities to engage with our customers on other topics which will increase the wider benefits of our proposals, such as keeping them informed about other support offerings, and providing education on water efficiency and appropriate sewer use.

We have considered the role of technology and innovation to support these improvements in three key areas:

- Use of community apps, and engaging customers in co-designing these.
- Targeting in-community cohorts, to leverage behavioural theory that shows customers are more likely to participate if their neighbours do.
- Development of more engaging, tailored communication materials.

Annex 07 Wellbeing benefits includes examples of how we can initiate community co-design.

3.1.3 Learning from others

We are drawing on learning from Portsmouth Water and United Utilities, which have already trialled techniques to improve the connection between the new supply pipe and the internal plumbing system. The new service pipe is relayed to the outside wall of the property, up into a box. It enters the property through the wall, where it is connected to the internal plumbing (Figure 17). The boxes can also house a meter, potentially saving costs of the boundary box (usually installed to house the meter at the property boundary).

Figure 17: Use of new technique to improve connections between supply pipes and internal plumbing

3.2 Where should we start and how far do we go?

3.2.1 Identifying optimum trial locations based on risks

Data on the location and material of customer-owned supply pipes is limited, as there has never been a statutory requirement to hold such data. We have used insights from a variety of data sources to identify the areas that would drive the greatest benefits. These insights include:

- Risk analysis on lead failures (enables us to target areas with the greatest lead risk).
- Chemical use and potential for phosphate disengagement.
- Leakage priority data (allows us to identify areas with the greatest potential for water saving) and AMP7 activity (specifically mains renewal and metering) that could be joined up in an efficient way to deliver more efficient overall outcomes.
- Deprivation data (enables us to target the most financially vulnerable customers).
- Information on property styles and ages (informs risk and helps us to ensure trials provide a statistically significant representation of different property types to inform future roll-out).

Lead risk

We reviewed the Drinking Water Safety Plan (DWSP) risk assessment status to identify locations where the lead risk is highest. This includes 'inherent risk', using property age older than 1972 as a proxy for risk of lead pipes, and 'realised risk' from the number of lead sample results breaching the regulatory limit for lead (10ug/l) and the number breaching the warning limit for lead (5ug/l).

We currently have no red risks and 21 amber risks for lead (Figure 18). Table 3 provides the list of amber lead risks and initial assessment comments. Figure 19 illustrates the amber risks by area within the Severn Trent region.

Figure 18: Map of Severn Trent region showing location of Zonal amber lead DWSP risks

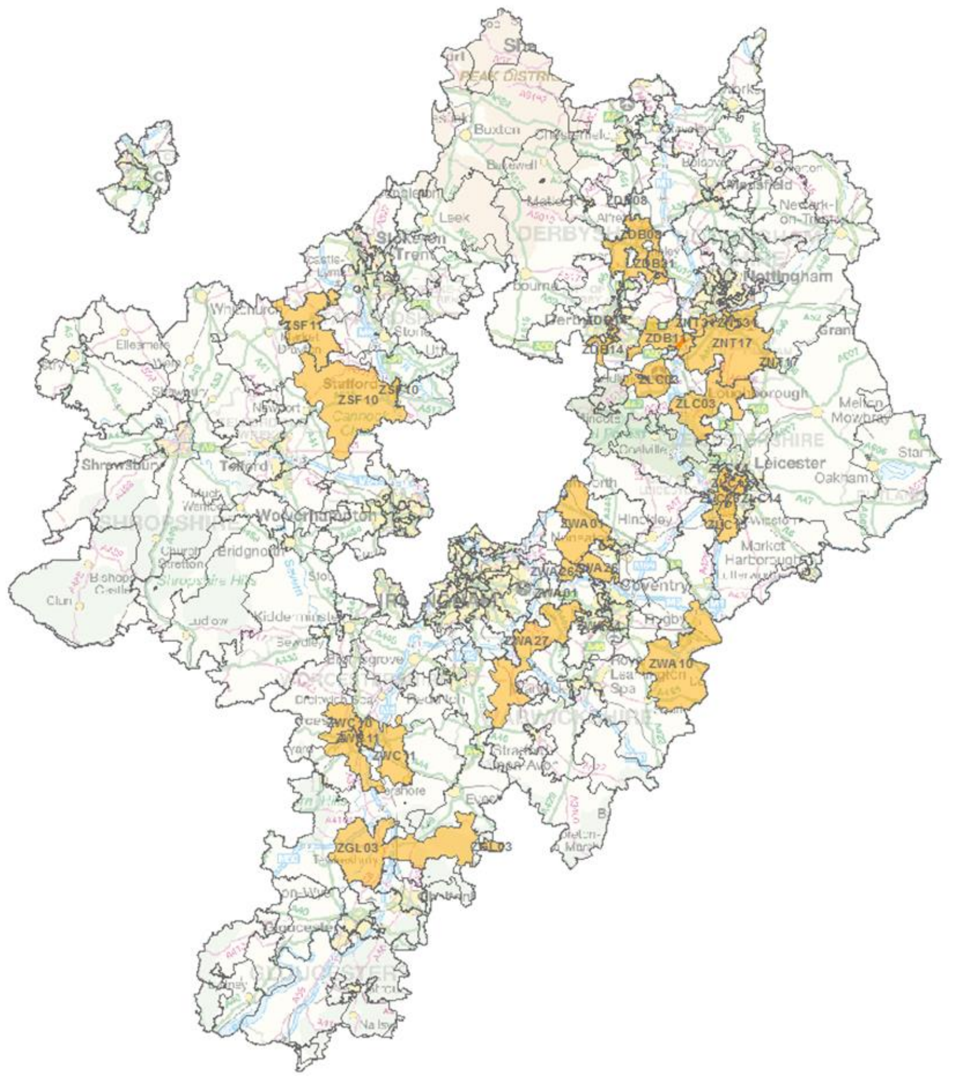
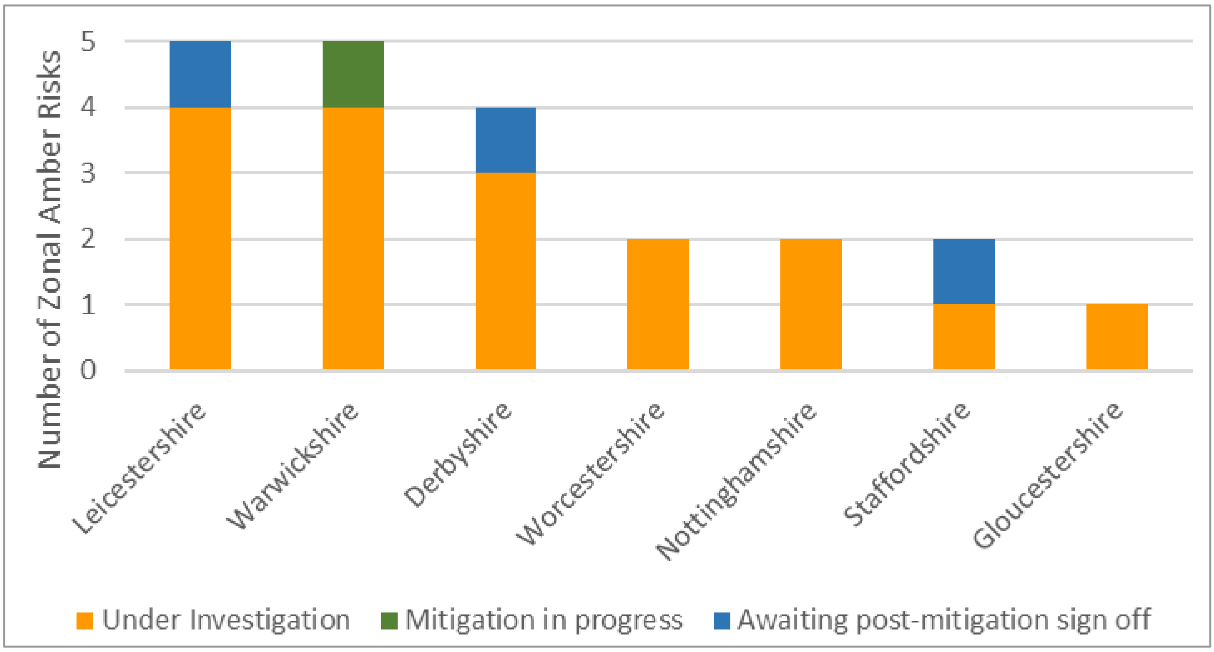


Table 3: Zonal amber lead DWSP risks with current category and risk mitigation activity

Zone ref	Zone name	County	DWI category	DWI category description	Comments
ZWA27	**Redacted**	**Warwickshire**	C	Improvement activity in progress	Capital PO4 improvement scheme at Henley in Arden DBS
ZLC13	**Redacted**	**Leicestershire**	B	Gathering validation data post-improvement activity	AMP6 Leics leads scheme completed & samples taken. Awaiting review.
ZDB21	**Redacted**	**Derbyshire**	B	Gathering validation Data post-improvement Activity	AMP6 [redacted] scheme completed & samples taken. Awaiting review.
ZSF11	**Redacted**	**Staffordshire**	B	Gathering validation data post-improvement activity	AMP6 Capital PO4 scheme at [redacted] BPS. Awaiting review.
ZNT31	**Redacted**	**Nottinghamshire**	E	Under investigation	Three hot spot areas identified capital requests raised.
ZDB08	**Redacted**	**Derbyshire**	E	Under investigation	Under distribution WQ review
ZWA01		**Warwickshire**	E	Under investigation	Under distribution WQ review
ZSF10	**Redacted**	**Staffordshire**	E	Under investigation	Under distribution WQ review

Zone ref	Zone name	County	DWI category	DWI category description	Comments
ZWA26	Redacted	Warwickshire	E	Under investigation	Under distribution WQ review
ZWA24	Redacted	Warwickshire	E	Under investigation	NEW – Under distribution WQ review
ZLC15	Redacted	Leicestershire	E	Under investigation	Under Distribution WQ review
ZDB11	Redacted	Derbyshire	E	Under investigation	Under distribution WQ review
ZLC03	Redacted	Leicestershire	E	Under investigation	Under distribution WQ review
ZLC29	Redacted	Leicestershire	E	Under investigation	Under Distribution WQ review
ZDB14	Redacted	Derbyshire	E	Under investigation	Under distribution WQ review
ZNT17	Redacted	Nottinghamshire	E	Under investigation	Under distribution WQ Review
ZWA10	Redacted	Warwickshire	E	Under investigation	Under distribution WQ review
ZGL03	Redacted	Gloucestershire	E	Under investigation	Hot spot identified in the GL20 area (DMA 07/102). Capital Request raised.
ZLC14	Redacted	Leicestershire	E	Under investigation	Under distribution WQ review
ZWC10	Redacted	Worcestershire	E	Under investigation	Under distribution WQ review
ZWC11	Redacted	Worcestershire	E	Under investigation	Under distribution WQ review

Figure 19: Zonal amber lead DWSP risks by area



The three Zones assigned a category B amber risk had already had improvement activity to address the lead risk and were awaiting final review sign off (one in Leicestershire, one in Derbyshire and one in Staffordshire). The Zone assigned a Category C was being addressed by capital work already in progress (Warwickshire). These Zones were therefore excluded from this review. Of the remaining amber Zonal risks, work had been progressing with investigations to review these, with the highest numbers in Leicestershire, Warwickshire and Derbyshire.

In terms of large urban areas, Leicester City itself had been the location for a large proactive communication pipe replacement scheme in AMP6, which left Coventry, Derby, Nottingham, Stafford and Worcester as cities to consider in the process, along with other criteria, for a large-scale trial. Of these cities, Stafford is the only one that is not phosphate-dosed. However, the DWSP investigation was indicating the Zonal risk had lowered, so this Zone was considered a lower priority in this assessment. The [redacted] zone, and was considered as an increasing risk. However, capital investment requests had already been raised through the normal investment route to cover three 'hotspot' locations in this area, so some mitigating measures are already in progress. This remains a potential option for this proposal going forwards if priorities change.

Chemical use and potential for phosphate disengagement

We also reviewed chemical usage and the potential for phosphate disengagement in our assessment of where to prioritise as our trial areas for this proposal. All surface Water Treatment Works (WTWs) dose at a minimum of 1.0mg/l, as well as the groundwater, DSR and booster sites listed in the table below. Several sites with higher dose rates are under optimisation review, following capital maintenance in AMP6 when the sites are initially commissioned at a higher dose rate. The sites with the highest phosphate dose rates set are in Warwickshire (see Table 4).

Table 4: Groundwater, service reservoir and distribution booster phosphate dosing sites with targets set at or above a minimum of 1.0mg/l

WTW / DSR / Booster Dosing Site	Minimum PO4 Targets mg/l	AMP6 CM	Region
[site names redacted]	1.5*	Y	Warwickshire
	1.5		Warwickshire
	1.5		Warwickshire
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire
	1.0		Central
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire
	1.0		Warwickshire
	1.0	Y	Staffordshire
	1.0	Y	Shropshire
	1.0		Warwickshire
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire
	1.0	Y	Staffordshire

We also reviewed the suitability of Zones to be candidates for phosphate disengagement trials. We undertook a review of discretely-fed Zones (usually by a small groundwater source with its own phosphate dosing rig). Table 5 shows the assessment of Severn Trent Zones with a population of less than 5,000 (in size order).

Table 5: Zones serving less than 5,000 population, and potential for phosphate disengagement

Zone ref	Zone name	Population	Supplying source(s) (PD = phosphate dosed)	Site not suitable				Site suitable
				Bulk import	Not PD	Multiple zones	Other	
ZNT18	[zone names redacted]	5	100% Anglian Bulk Import	X				
ZSF06		14	100% UU Bulk Import	X				

ZWC21	17	100% Welsh Water Bulk Import	X				
ZSP34	40	100% HD Bulk import – Llandinam	X				
ZSP20	132	100% Welsh Water Bulk Imports	X				
ZLC19	204	100% Anglian Bulk Import	X				
ZWC16	398	52% Brockhill (NOT PD), 48% Burcot (NOT PD)		X			
ZWA17	612	100% South Staffs Bulk Import	X				
ZSF04	1062	100% Greatgate (PD)			X		
ZSP32	1450	46% Kinnerley (NOT PD), 32% Pentre (NOT PD)		X			
ZSF14	1808	100% Tittesworth			X		
ZGL14	1931	61% Big Well (NOT PD), 15% Lydbrook (NOT PD)		X			
ZSF03	2570	54% Eastwall (NOT PD)		X			
ZSP02	2792	100% Bomere Heath					X
ZWC22	3504	59% Astley (NOT PD)		X			
ZSF29	3607	68% Hilton BPS (PD)			X		
ZSF35	3709	100% Croxton BPS					X
ZWA28	4331	100% Mount Nod BPS					X
ZSP27	4498	100% Blackstone (NOT PD)		X			
Z14	4908	100% Plemstall WTW (DV)				X	

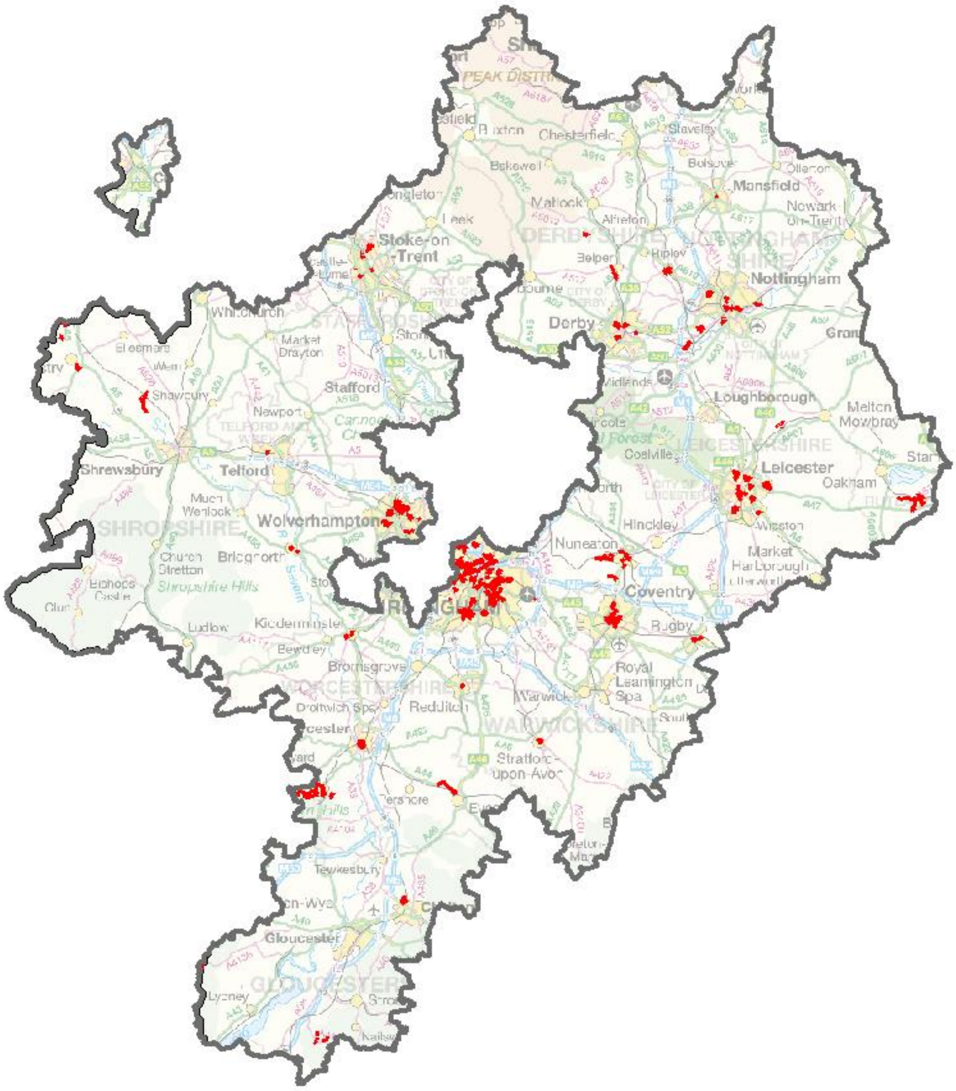
Our smallest Zones are bulk supplies, so we are not able to influence the phosphate disengagement potential of those. A number of small Zones, e.g. [redacted], do not receive sufficient phosphate-dosed water, so are not candidates for phosphate disengagement. [redacted] Zone has a population of just over 1,000 people and is supplied by [redacted]. However, at least one other Zone is reliant on phosphate-dosed water from [redacted] as a source, so it is not the best initial candidate for phosphate disengagement. Bomere Heath Zone was identified as the smallest Zonal candidate, served discretely by [redacted].

Leakage priority and AMP7 activity (mains renewal and metering)

For an overview of key areas where leakage was being targeted, we examined our model to identify cost-efficient areas to tackle leakage with mains renewal activity, based on leakage detection rates, mains burst rates and the modelled consequence and likelihood of failure. We then carried out further verification and validation of leakage levels in the areas identified from the model to assess and promote schemes for mains renewal in AMP7. We have already promoted some schemes because of this review, while others are mid-way through validation.

The areas the model has highlighted are shown in Figure 15. Birmingham and Wolverhampton have the biggest area of focus, followed by Coventry, Nuneaton, Worcester, Malvern, Kidderminster, Leicester, Oakham, Nottingham, and small areas of north Staffordshire and Shropshire.

Figure 20: Locations of the model outputs where mains renewal is being targeted to tackle leakage across the Severn Trent region



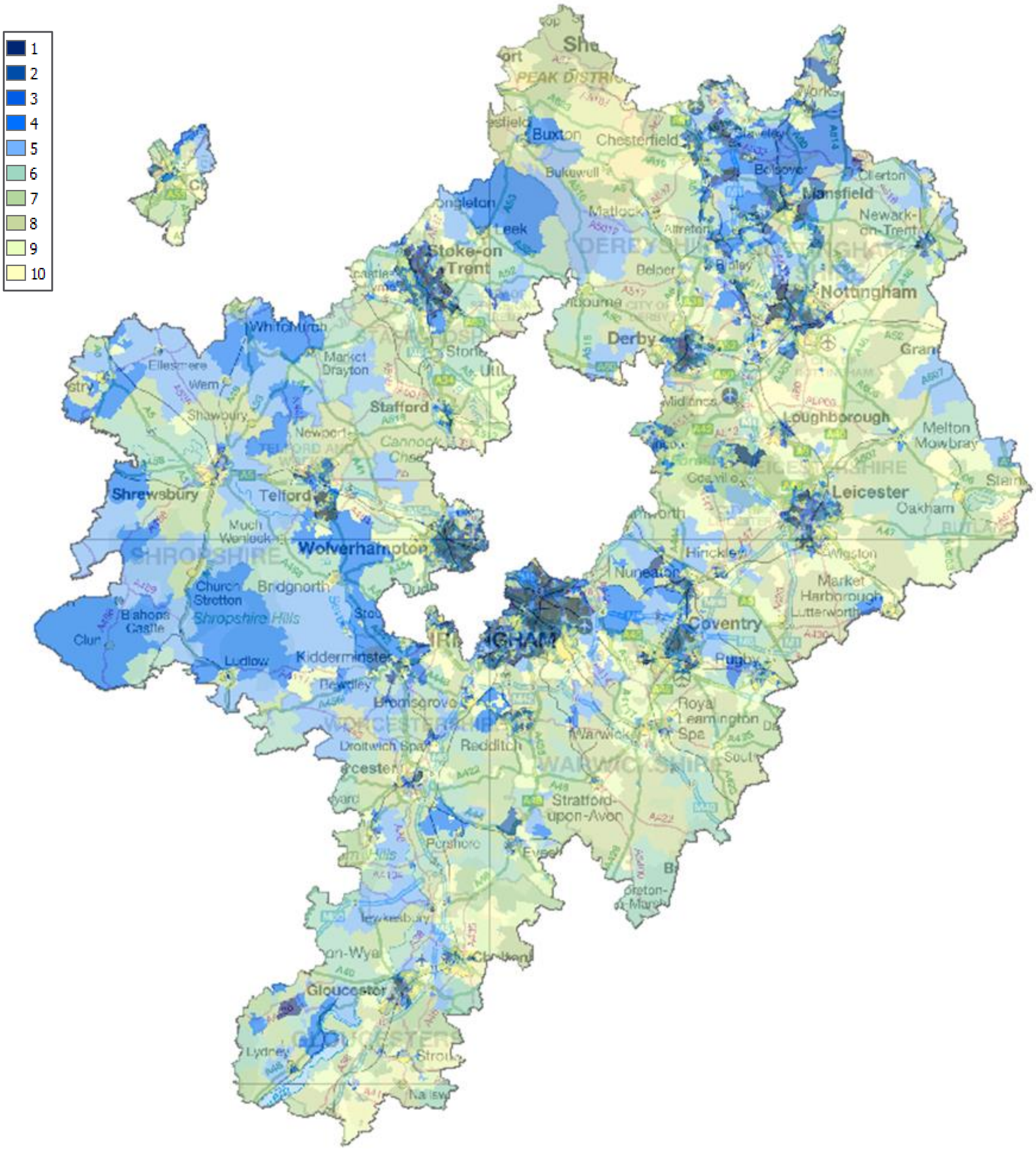
We reviewed Water Resource Zones with a water deficit which highlighted three potential focus areas – the Strategic Grid, Nottinghamshire and North Staffordshire. The Strategic Grid Zone includes Birmingham, Warwickshire, Derbyshire and Worcestershire. We also considered a more detailed review of DMA leakage, normalised per property and km of main, as the prioritisation assessment progressed.

Another area for exploring potential synergies is water metering roll out. Although we do not have any formally designated water-stressed areas, our strong water efficiency drive is supported by our AMP7 metering roll out, which focuses on Nottingham and north Staffordshire. Our Green Recovery smart metering proposal is also targeting Coventry and Warwick with an ambitious smart meter roll out.

Areas of deprivation

We used the Government's Index of Multiple Deprivation (IMD) 2019 by Lower Layer Super Output Area (LSOA)[19] to assess where the areas of highest deprivation are in our region. The Index contains multiple deprivation measures with different weightings, such as income (22.5%), employment (22.5%), education, skills and training (13.5%), and health and disability (13.5%). Areas are ranked and split into ten equal deciles, where 1 represents the 10% most deprived areas, and 10 represents the 10% least deprived areas (see Figure 16).

Figure 21: IMD 2019 data by LSOA across the Severn Trent region



This image shows areas such as Birmingham, Wolverhampton, Stoke-on-Trent, Derby, Nottingham, Coventry, Leicester and Telford have some of the lowest deprivation areas within them in our region.

[19] Ministry of Housing, Communities and Local Government English Indices of Deprivation 2019 – https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019

This is further supported by the ranking of Local Authorities in the Severn Trent region, out of 317 English Local Authorities (Table 6):

Table 6: Index of Multiple Deprivation (IMD) for Local Authority districts in the Severn Trent region

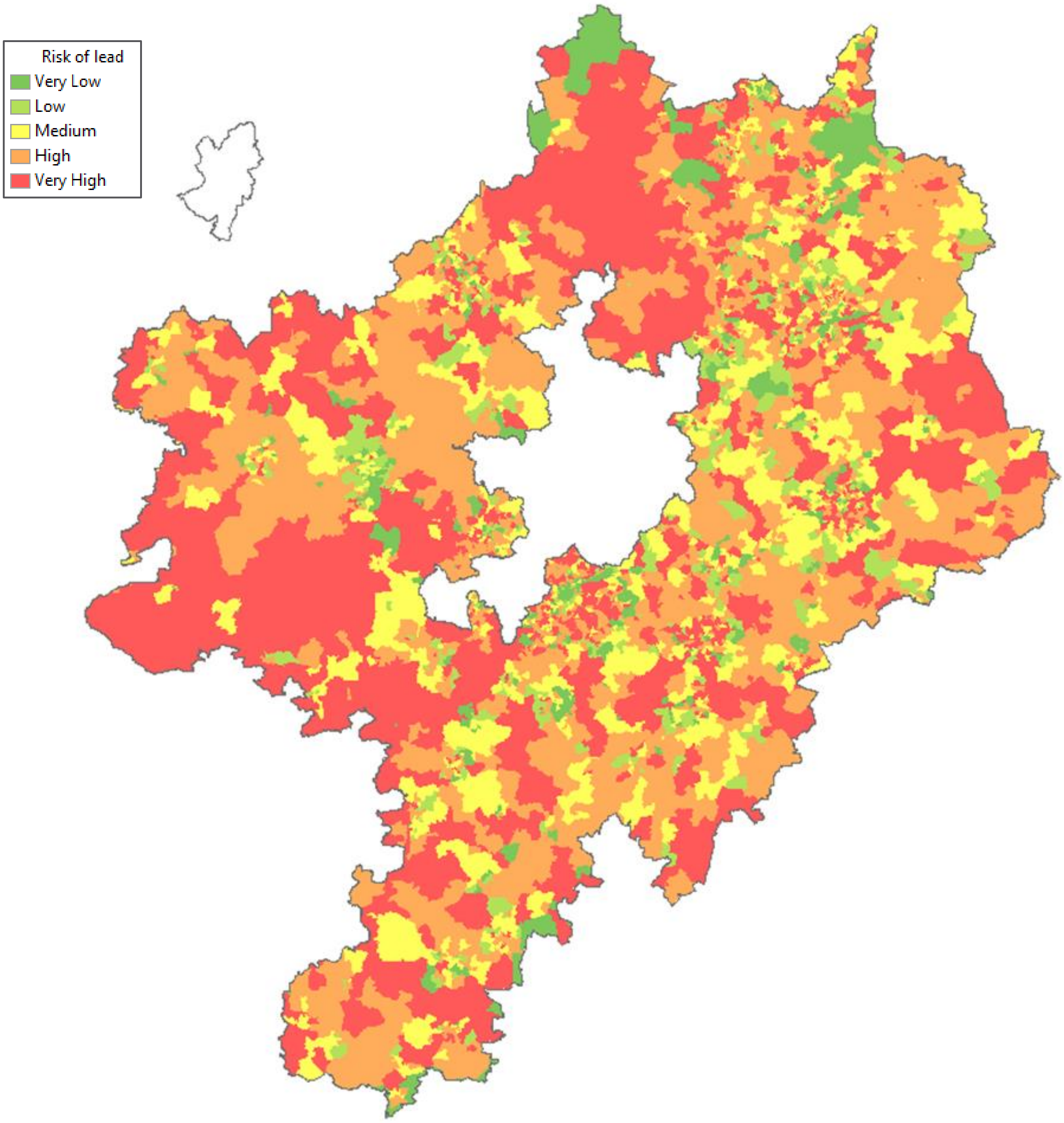
Local Authority District code (2019)	Local Authority District name (2019)	IMD – rank of average rank	IMD – rank of average score
E08000025	Birmingham	6	7
E06000018	Nottingham	10	11
E06000021	Stoke-on-Trent	15	14
E08000031	Wolverhampton	19	24
E06000016	Leicester	22	32
E07000174	Mansfield	56	46
E08000026	Coventry	81	78
E07000034	Chesterfield	86	87
E06000015	Derby	90	67
E07000219	Nuneaton and Bedworth	101	96
E07000199	Tamworth	125	126
E07000081	Gloucester	138	118
E07000175	Newark and Sherwood	148	145
E07000195	Newcastle-under-Lyme	150	151
E07000218	North Warwickshire	155	167
E07000193	East Staffordshire	157	147
E07000237	Worcester	159	135
E06000051	Shropshire	165	174
E07000038	North East Derbyshire	177	170
E06000050	Cheshire West and Chester	183	161
E07000235	Malvern Hills	187	192
E07000037	High Peak	202	201
E07000198	Staffordshire Moorlands	204	206
E08000029	Solihull	206	171
E07000134	North West Leicestershire	216	214
E07000039	South Derbyshire	218	215
E07000220	Rugby	222	224
E07000221	Stratford-on-Avon	259	266
E07000222	Warwick	263	259
E07000035	Derbyshire Dales	265	263
E06000025	South Gloucestershire	267	269
E07000234	Bromsgrove	271	268
E06000017	Rutland	303	303

We used this data to assess general areas of deprivation in the prioritisation review, along with the more granular LSOA data to identify more specific deprivation areas within those locations.

Information on property styles and ages

We used a previous assessment Atkins undertook on our behalf in 2017 for property age assessment at District Meter Area (DMA) level (see Figure 22).

Figure 22: Atkins lead risk index based on age of property data for the Severn Trent region



The accompanying data tables were used to focus the assessment within the shortlisted areas to the actual numbers of properties within each of the higher risk areas. This again led prioritisation towards the large urban centres, but enabled refinement of areas to target within these locations.

Information on property type categorisations (e.g. detached, semi-detached, terraced) were also used in the assessment to get a variety of properties across the targeted trial areas. This will ensure that the trial will provide a deeper understanding of costs of different type of supply pipe configurations, entry points and environmental factors.

We have also used CACI Acorn Data to understand the customer segmentation in the areas we are reviewing. This large geo-demographic dataset segments households and neighbourhoods into groups and categories based on social factors and population behaviour. This will help feed into our analysis of the factors influencing supply pipe replacement decisions as well as allowing us to compare the locations in the trial proposals.

3.2.2 Scaling the trial to gain maximum impact

As explained above, the lack of robust information on customer supply pipes is a significant challenge. We have used the information that is available to estimate the scale of the work needed. To do this we have made assumptions on the following factors:

- How many pipes are likely to be made of lead.
- How many pipes are likely to be leaking.
- What degree of overlap should we expect (i.e. how many will be both lead and leaking).
- How many customers will agree to participate in the trial (uptake rate).

We have summarised these assumptions in Table 7.

Table 7: Summary of our assumptions in estimating the scale of supply pipe replacement works

River	Number of properties/ pipe replacements		Basis of assumption
	Min	Min	
Leakage	19%	33%	Min: 19% properties built since 1990[20], suggesting pipe age <30 years = unlikely to be leaking Max: Industry assumption (UKWIR) between a quarter and a third of all leakage is on supply pipes.
Lead	20%	50%	Min: Atkins study 2017 Max: Properties older than 1970
Customer uptake rate	6%	70%	Min: Welsh water lead replacement trial Max: judgement based on uptake rate on pledges through education programme

The degree of overlap between pipes that are leaking that are also made of lead is also unknown. Therefore, in each potential trial area we have considered three scenarios:

- Scenario 1: Zero overlap, meaning none of the lead pipes we identify are leaking and none of the leaking pipes we identify are made of lead.
- Scenario 2: 100% overlap, meaning that all pipes we identify are both leaking and make of lead.
- Scenario 3: 50% of the pipes are both lead and leaking and the other 50% are either only lead or only leaking.

As described in section 3.1, we are developing technology and looking for innovative solutions that help us better target the locations of both lead and leakage, which means we are likely to perform somewhere between scenario 2 and 3. We calculated the range under each scenario and then made location-specific judgements to decide on the best central estimate in each case. This is set out in section 4 where we detail our proposals.

[20] https://www.designingbuildings.co.uk/wiki/English_housing_stock_age plus additional 0.8m built between 2025 and 2019 from https://www.statista.com/statistics/1021755/number-of-dwellings-england-by-county/

3.3 How we will deliver these proposals to maximise benefits

3.3.1 Engaging with our customers

Our customers are at the heart of this proposal – we will be unable to deliver any benefits from these proposals without their support and engagement. Many customers are not even aware that they may have lead or leaking pipes. Therefore, it's essential that we have a vibrant education and awareness campaign in our trial areas to maximise customer uptake to the scheme that empowers and reassures our customers, plus the right access to support and information throughout the journey on the scheme.

We know customers want to be informed about supply pipe issues from our customer insight survey, and we will utilise a mixture of traditional methods, such as leaflets and posters, and digital methods, such as targeted social media, to engage customers. We plan to revamp our website with a dedicated page for this scheme, which will be a hub of information, including case studies, photographs of before and after supply pipe replacement, and Frequently Asked Questions. Open and honest communication is essential for customers and we will provide this support through communication specialists, learning the importance of this from our Birmingham Resilience Programme.

Our customers told us they'd like to be informed through community routes, such as churches, community centres and schools. In addition to other community-based awareness campaigns, we plan to run family focussed community events with our education team to promote this supply pipe replacement scheme, including other aspects such as water efficiency and affordability support for water bills, as well as the prime drivers of lead pipe awareness, customer-side leakage and pipe responsibilities. This will improve customer accessibility and harness wider benefits. Within our engagement package we have also included an App for customers to take part in designing the community benefits following supply pipe replacements in their area.

We have included a range of engagement techniques, as we're conscious our approach needs to be bigger and bolder, given the low uptake rates of early trials within the industry that we're learning from. Despite this, we believe that with the right approach and the right scheme, talking to customers about the benefits of removing lead pipes and reducing leaks, will result in a sizable number of customers who wish to benefit from this proposal.

3.3.2 Supply pipe delivery approaches

Under the current supply pipe ownership model, water companies are not responsible for supply pipes. This means that homeowners have access to the market when choosing who they want to carry out the work. As discussed in section 1, customers do use a range of service providers. From our research it showed that 44% used registered water safe plumbers, 22% did it themselves, 13% used local plumbers and 14% used a contractor as part of a larger home renovation project. It is therefore important that we continue to consider the market options when setting up the delivery route of these proposals. We have considered the following main options in Table 8:

Table 8: We have considered three main delivery route options

Option	Model	Description
1	In- house delivery	We offer the service to the customer. Option for a legal agreement to be produced to adopt the asset and its liabilities to Severn Trent.
2	Customer grant	We pay for the work via a grant (to a maximum cap) and specify that the work is undertaken by a Watersafe approved plumber.
3	Outsourced model	We open the work to tender to replace a programme of supply pipes.

Irrespective of delivery model, customers will be given the choice for Severn Trent to take ownership of the pipe as part of the work. This will reveal valuable insight on the public appetite for transfer of ownership.

We think it is important to include option 1 (in-house delivery) for three reasons: 71% of the customers who we surveyed thought that supply pipe replacement should be carried out by water companies; we want to drive efficiency savings through synergies and innovation; and want to understand the customer appetite for ownership to be transferred to water companies. Through testing these different models, we will gather critical evidence on costs, pipe replacement techniques and customer views to help inform future policy.

We have assessed the delivery model options and concluded that the best approach is to use a combination of all three options. This enables these ambitious outcomes to be delivered, mitigates anti-competition risk and enables testing comparison of these delivery models as part of the trials (see Table 9).

Table 9: We have assessed the benefits and drawbacks of each delivery model option

Option	Model	Advantages	Disadvantages
1	In-house delivery	• Allows synergies with mains renewal programme • Allows synergies with metering programme • Allows statistically significant results on customers long term ownership preference • Allows us to consider phosphate disengagement within discrete zones depending on uptake rate • Creates additional jobs	• Does not enable open competition
2	Customer grant	• Open market to drive competition • Offers customer choice	• Administratively burdensome due to the size of Coventry • Limits ability to leverage synergies • Inconsistent approach to customer engagement and workmanship • Uncertainty if the market can support this level of activity
3	Outsourced model	• Open market to drive competition • Minimal burden for us	• Limits ability to leverage synergies • Less opportunity to drive greater benefits through education and customer engagement • Uncertainty if the market can support this level of activity

We have already taken steps to mitigate the one disadvantage of the in-house model by comparing the proposed costs with those that we forecast on company-owned sections of pipes. This allows us to ensure that the proposed costs relate to already market-tested cost data (see section 5, cost robustness).

Some of the trial areas may lend themselves more to one or two of the delivery methods, but overall we have forecast that around 6,000 of the 30,000 supply pipe replacements are likely to be delivered by the Customer Grant model, 12,000 will be delivered by an in house model, and 12,000 will be delivered by contractors, but these proportions may vary in response to customers' uptake and preference.

3.3.3 Trade stakeholder engagement and quality standards

We promote quality and standards assurance through [managing] the Severn Trent Regional Watermark Scheme and supporting the National Watersafe Scheme. We have provided training to plumbers and contractors in order for them to becomes members of the Scheme, to ensure they demonstrate the understanding of the Water Fittings Regulations needed to qualify for membership.

The importance of good workmanship during supply pipe replacement was highlighted by our customers in our customer insight survey, as well as good communication. As part of this proposal, we aim to expand this training and promotion of the Watermark and Watersafe Schemes with a focus within the trial areas, to raise and maintain standards. We will be opening the new Severn Trent Academy doors in 2021, and this training will have its base there. Interactive training boards, classroom learning and practice pipe rigs are some of the facilities available. We will offer plumbers, installers and contractors who are qualified in supply pipe replacement and reinstatement incentives to be part of the Scheme and additional customer-focussed soft skills training.

These tradespeople and contractors are key to the delivery of this proposal's ambitious targets and we will need their expertise as well as our own in order to maximise deliverability. We will also seek feedback from these stakeholders to shape and improve the scheme and learn lessons for future approaches.

3.4 Assessment of options

In sections 3.1 to 3.3 we have detailed the possible technology and locations which we could target and the options for carrying out the work. This section sets out how we have selected from those options in order to:

- Gain maximum possible short-term primary benefit in terms of the number of households who no longer face the risks associated with lead or leaking pipes.
- Drive wider public value through levelling up (supporting financially vulnerable customers) and maximising opportunities for wider benefits through greener streets and maximising customer contact.

Maximise the learning emphasised in the DEFRA Supply Pipe Consultation Summary of Responses in 2014[21], which stated that:

"Defra and the Welsh Government believe that, having assessed the evidence and views, there are benefits to be gained from transferring ownership of private supply pipes to water supply companies. However, there is less certain evidence about the range of potential impacts on water bills for various customers and geographical regions".

We can use this learning to benefit all our customers – and our industry as a whole. We think it is important to balance the benefits to customers included in the trial with wider gains to ensure our proposal is fair and benefits all customers equally over the longer term.

[21] DEFRA Supply Pipe Consultation Summary of Responses – https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/337190/water-supply-pipes-consult-sum-resp.pdf

We have reviewed all the analysis relating to the criteria set out in table 10 to enable us to select the best locations for the trial .

Table 10: Summary of the prioritisation criteria for each of the identified locations

Criteria	Coventry	Derby	Notts	Worcester	Loughborough	Bomere Heath (Shrops)
Lead risk	Medium-High	High	High	High	High	Medium-Low
Opportunity to disengage phosphate dosing	Partial	No	No	No	No	Yes
Water Deficit and Leakage potential	High	High	High	High	Medium	High
Opportunity for AMP7 synergies	Mains Renewal & Metering	Mains Renewal	Mains Renewal & Metering	Mains Renewal	None	None
Opportunity to support vulnerable customers	Very high	Very high	Very high	High	Medium	Low
Representative mix of properties	Mostly urban	Mostly urban	Mostly urban	Rural-Urban mix	Rural-Urban mix	Rural
Joint Supplies	High	Medium	High	Medium	Medium	Low
Existing relationships with third parties	Colleges & Academy	Colleges	N/A	N/A	N/A	N/A
Scale enable offering to whole area	Yes	No	No	Partially	Yes	Yes

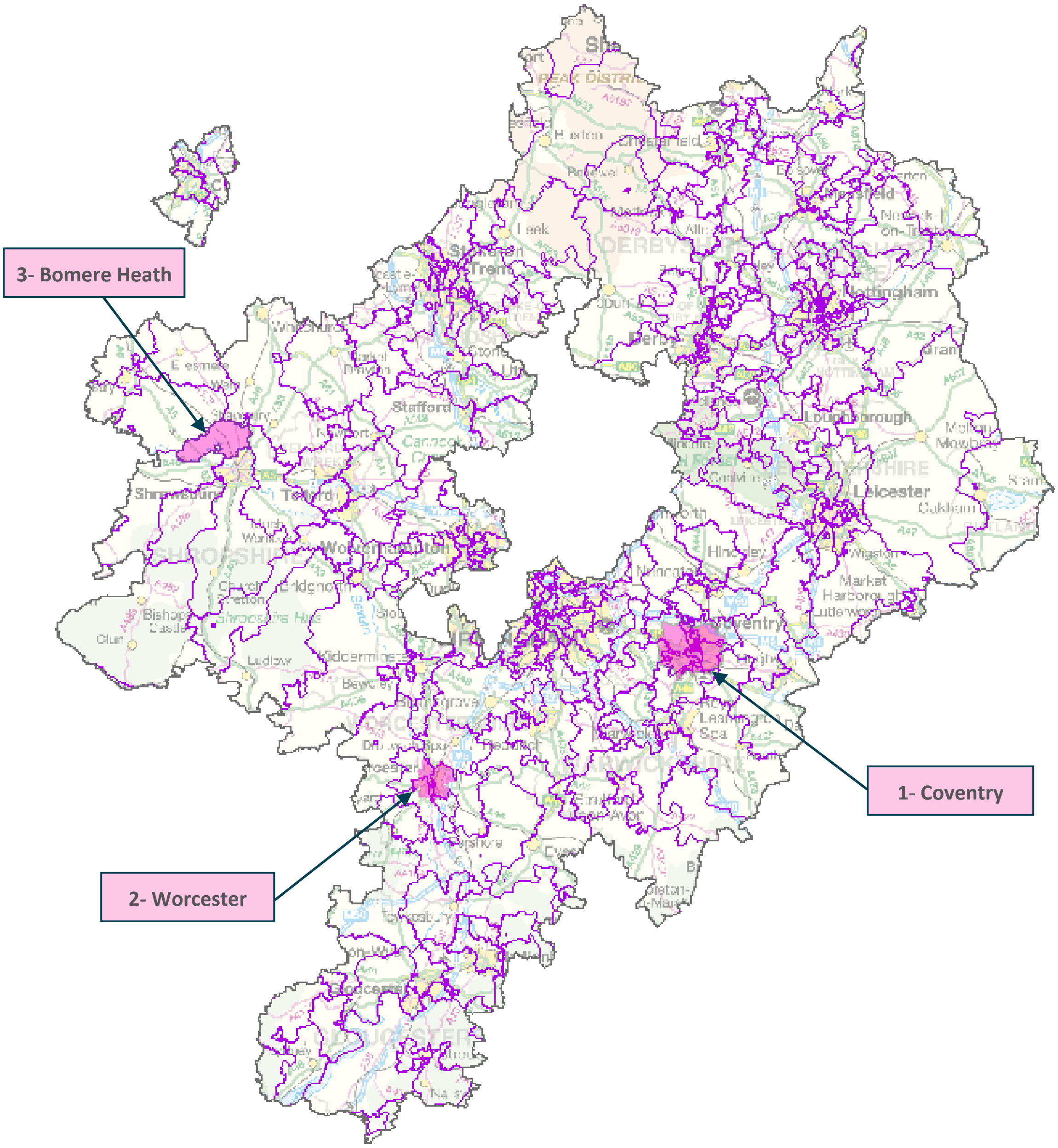
The above analysis provides a prioritised list of areas based on the relative contribution each would offer against the drivers of this proposal. It is clear that it is possible to trial any of the delivery models outlined in section 3.3.2. Therefore, this is not a limiting factor in deciding on the location and should be decided after we have identified the right locations (to allow mapping of the best approach to the locations selected).

4. Our proposal

As shown in Table 10, no single location meets all the ideal criteria. Therefore, we have identified three locations, that when combined address all the aims of this proposal:

1. Coventry
2. Worcester
3. Shropshire – Bomere Heath

Figure 23: Severn Trent Map showing the three trial locations selected (pink), with water quality zone boundaries shown in purple

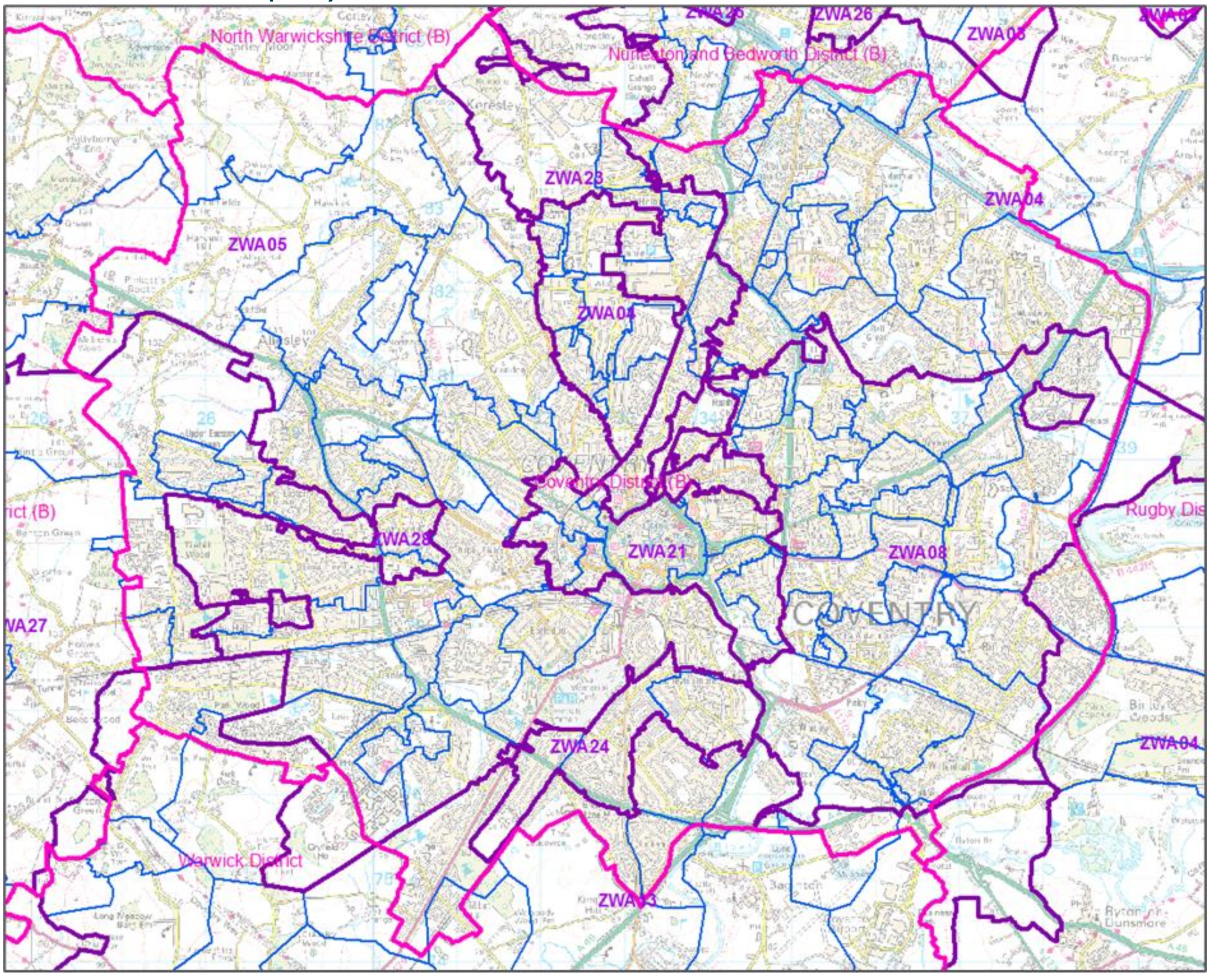


4.1 Trial 1: Coventry

Coventry has an industrial past, especially with the automotive industry. The rate of house building in the early 1900s expanded significantly during the 1920s and 1930s. However, the city was severely bombed in the Coventry Blitz in 1940. As a result there is a lot of post-World War 2 housing.

Coventry supplied across nine Water Quality Zones (WQZs), 122 DMAs (smaller areas that we use to assess water balance) and serves around 370,000 customers (Figure 24).

Figure 24: Map showing Coventry District Council Boundary (pink), Water Quality Zones (purple) and DMA boundaries (blue)



Some WQZs in Coventry have had historically higher levels of lead, and phosphate dosing levels have been higher in these areas as a result. The results from the analysis described in section 3.2 are shown in Figures 25 to 28:

Figure 25: Geospatial identification of lead risk Coventry (Atkins 2017)

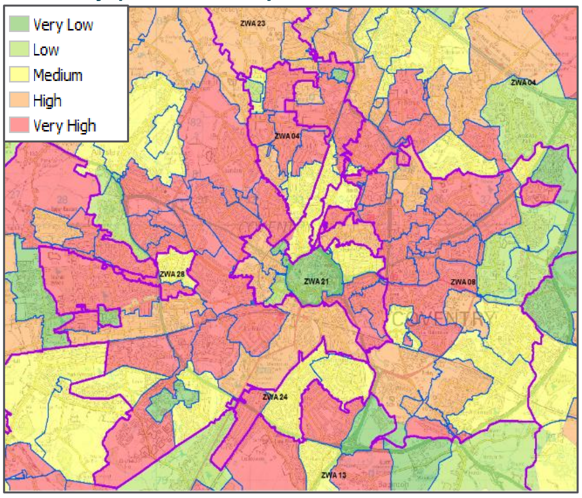


Figure 26: Lead sample hotspots in Coventry

[redacted]

Figure 27: Deprivation areas in Coventry

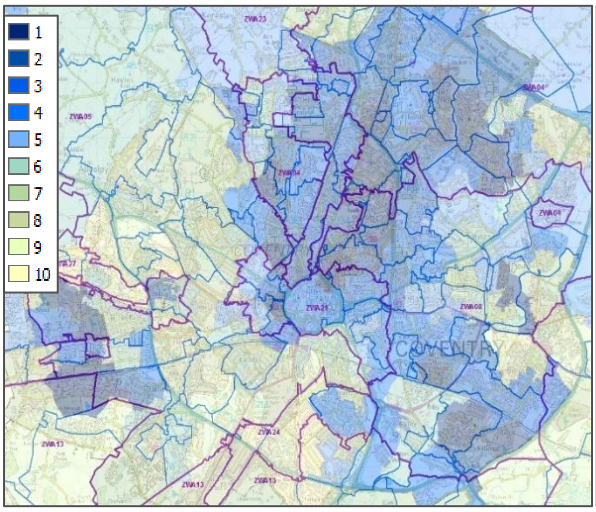
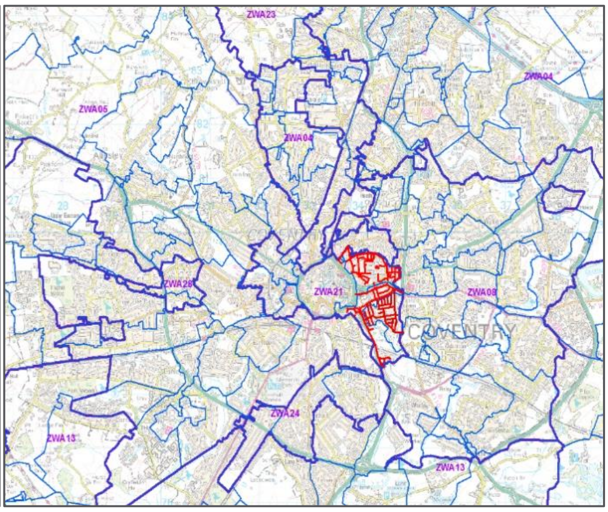


Figure 28: DMAs with mains renewal in Coventry



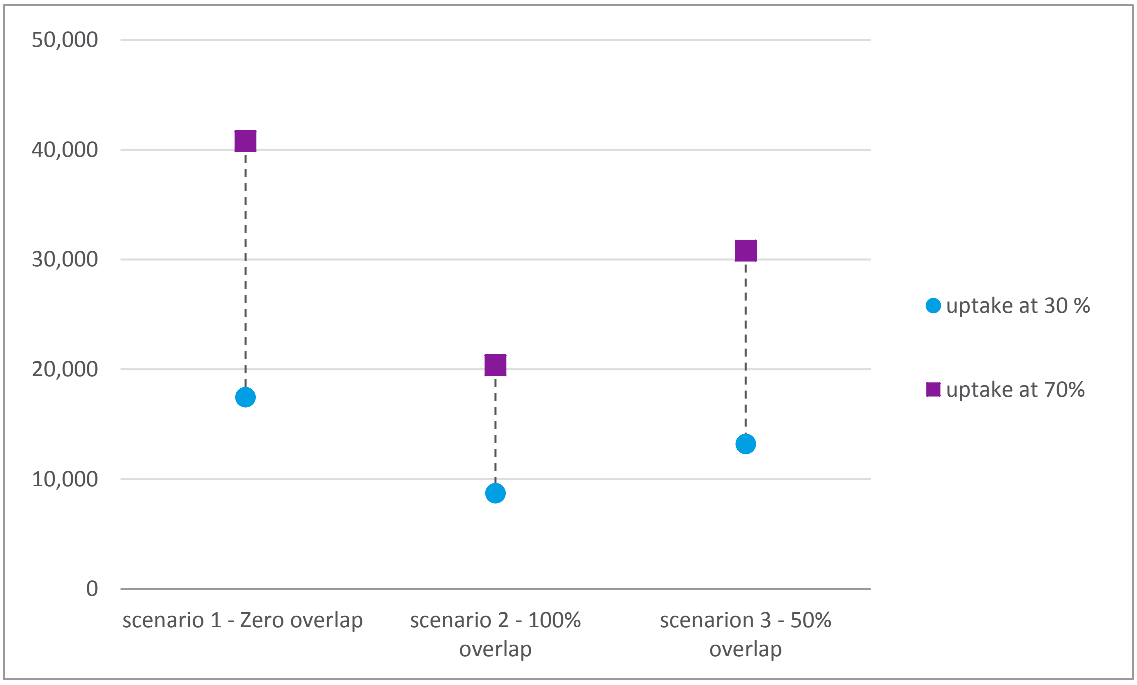
This data allows us to better target action and as a result:

- We will prioritise action in north east Coventry, where lead hot spots and deprivation are highest.
- We will align the work in central east Coventry with our mains renewal work so that we can lock in up to [redacted] of synergies because we will already be replacing the company-owned section of pipe (communication pipe) as part of our AMP7 mains renewal programme (estimated from 50% uptake rate totalling 910 properties in two Coventry DMAs that are high certainty mains renewal schemes). This DMA will offer additional learning as it means following completion of both the supply pipe replacement and our AMP7 programme 100% of the DMA will have pipework less than five years old. This will be a valuable baseline for leakage performance.
- We will align this proposal with the metering programme included in the smart metering Green Recovery proposal, which will result in that proposal making efficiencies of up to [redacted], due to the synergies between these programmes, as they will be installed whilst replacing supply pipes for this proposal for an anticipated 25,000 properties.

- If we can achieve a 100% uptake rate, there is also an option to target the two DMAs fed by Mount Nod WTW with a view to removing phosphate dosing in this discrete area of less than 2,000 properties.

To estimate the number of pipe replacements that will be needed in this area we have applied the method set out in 3.2.2, which has enabled us to calculate the forecasts shown in Figure 29:

Figure 29: Forecast number of replacements for three predicted scenarios



Based on the assumption that we can achieve uptake rate at the higher end, and the fact that we can apply the innovations outlined in section 3.1 to better identify lead and leaking pipes, we estimate that 25,000 pipes will need to be replaced to substantially remove lead and leakage from the water system in Coventry.

Joint supplies are more prevalent in Coventry than in the other trial areas, so this is where we are likely to undertake a large proportion of the 4,000 joint supply separations proposed. See Appendix 1 for more details on Joint Supplies.

4.2 Trial 2: Worcester

Worcester is covered by two Water Quality Zones – the Worcester City Zone (ZWC10) and the Worcester Rural Zone (ZWC11) – both of which are amber DWSP risks for lead. Although the WQZs extend wider than the boundary of Worcester District Council, most of the properties are within this area, across 38 DMAs and they serve around 102,000 customers (Figures 30-34).

Figure 30: Map showing Worcester Trial Area

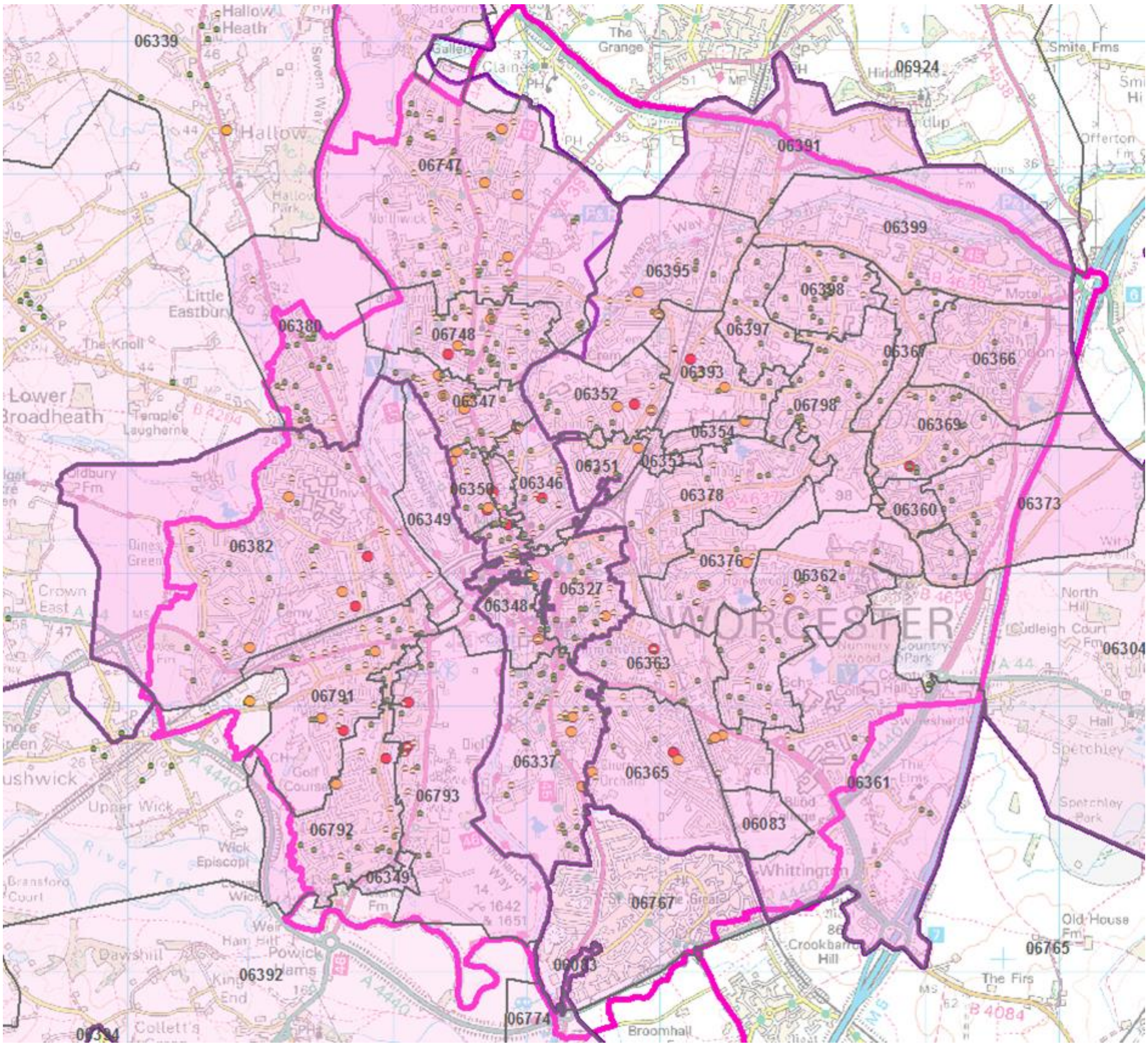
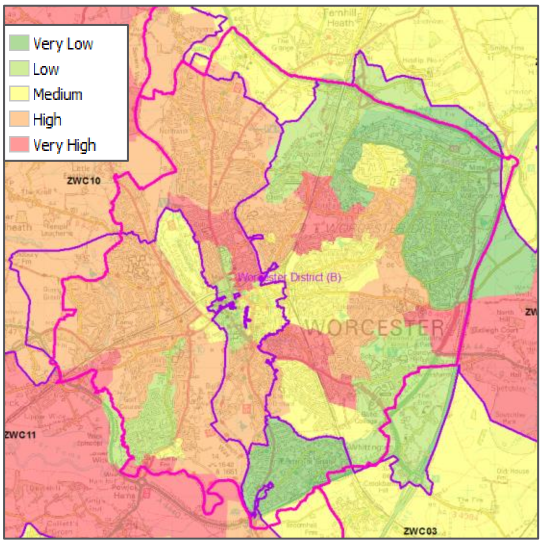


Figure 31: Geospatial identification of lead risk In Worcester (Atkins 2017) ***Figure 32: Lead sample hotspots in Worcester***



[redacted]

Figure 33: Deprivation Areas in Worcester

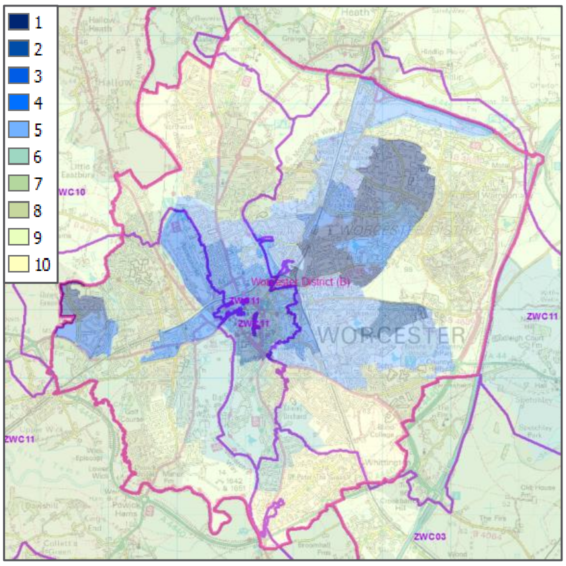
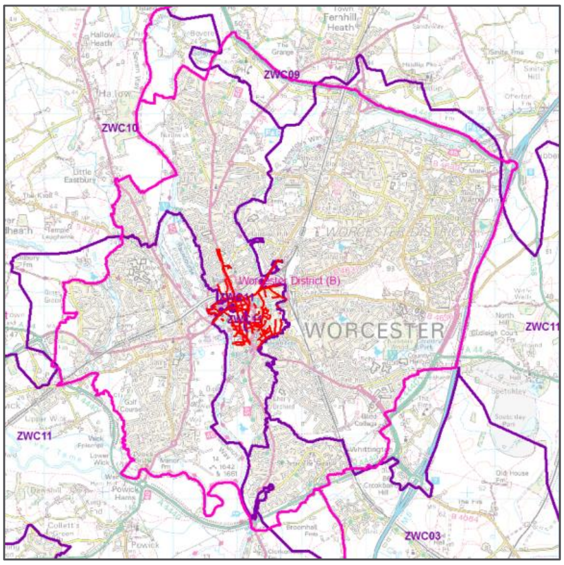


Figure 34: DMAs under consideration for mains renewal in Worcester



We have selected Worcester primarily because it is one of the highest areas in terms of lead risk. Worcester is a Victorian city with many houses that were built pre-1900 and between 1900-1919, and many are understood to have lead pipes. However, some of the housing estates at the outskirts to the South and the East of the city are showing some newer properties, so lower risk of finding lead pipes.

There is also a mixture of urban areas and rural areas and leakage is high in some of these DMAs. Standard water meters will be installed as part of this location's trial.

There is also an extreme range of deprivation levels, from the most deprived to the least deprived providing great potential to understand how deprivation level impacts customer perspectives on supply pipe replacement and other related factors that influence this. The most deprived areas will be targeted first for the scheme, with awareness and education campaigns run for the whole of Worcester with support and advice. Around 4,000 supply pipes will be targeted in this area.

4.3 Trial 3: Bomere Heath, Shropshire

The Bomere Heath Zone consists of three DMAs in a rural area of Shropshire, north of Shrewsbury, with just over 1,000 properties (Figures 35-39). [redacted].

Figure 35: Map showing Bomere Heath Trial Area

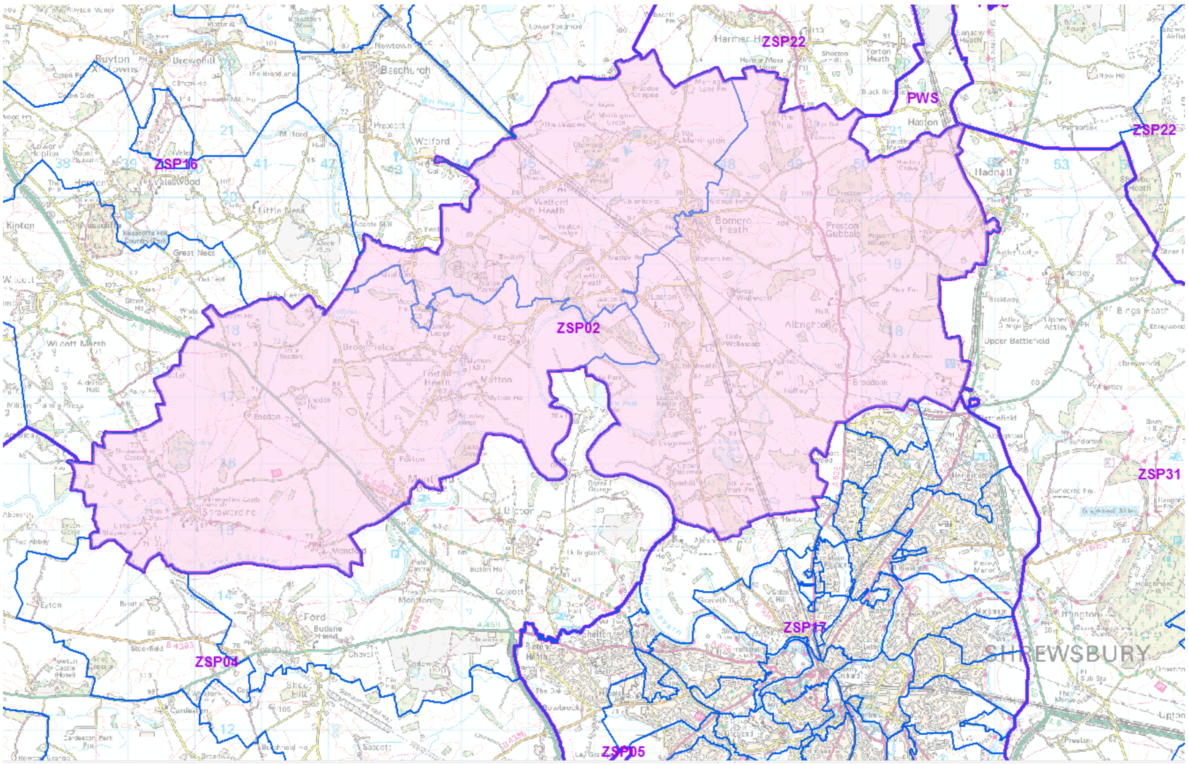


Figure 36: Geospatial identification of lead risk in Bomere Heath (Atkins 2017)

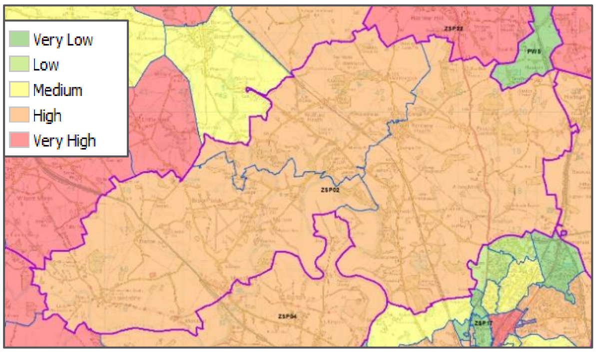


Figure 37: Lead sample hotspots in Bomere Heath

[redacted]

Figure 38: Deprivation Areas in Bomere Heath

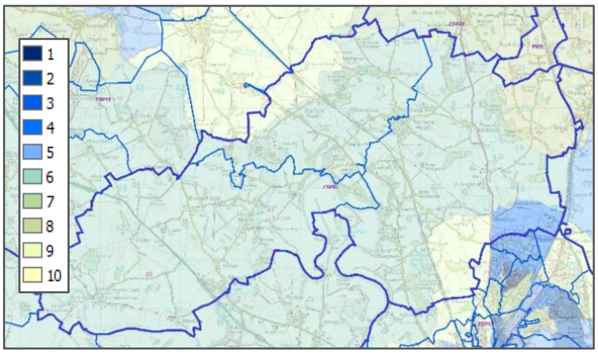
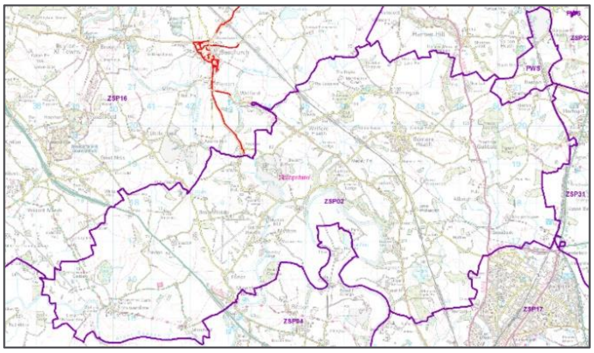


Figure 39: DMAs under consideration for mains renewal adjacent to Bomere Heath



This discrete area is supplied by [redacted], which has had phosphate dosing in place since 2002, originally assessed to be at a high risk of lead. It is now a yellow DWSP risk, with the risk mitigation in place of phosphate dosing. It still has a medium to high inherent lead risk, but with the mitigation in place, sample results have been low, with no breaches of 10ug/l in the past 5 years, and only one result above the 5ug/l warning limit.

We chose this area because it offers our best chance of completely removing phosphate dosing due to the relatively small size of the community, offering an ideal setting to test community engagement techniques to try and understand what it takes to achieve 100% customer engagement and participation in the scheme. If customer uptake is sufficient, we will develop a blueprint for phosphate disengagement and use this learning to inform PR24 and future investment plans.

The deprivation ranking is mid-index, but consistent throughout the whole area. DMA leakage levels are also relatively high in this area, and standard water meters will also be installed as part of this location's trial.

Managing uncertainty

As explained in section 3.2.3, we have made assumptions about hit rates in finding lead, leaking pipes and convincing customers to engage in the trial. The locations will therefore not be fixed. If we don't succeed in getting the hit rates assumed to drive the forecast benefits, we will reassess and choose the next high priority area. We will follow the above methodology to ensure the optimised highest risk areas are tackled, to maximise customer benefit and environmental outcomes.

More details on how we will protect customers considering this uncertainty are set in *Annex 11 Customer protection*.

5. Benefits of the proposal

We are targeting a wide range of benefits through this proposal, summarised in Table 11:

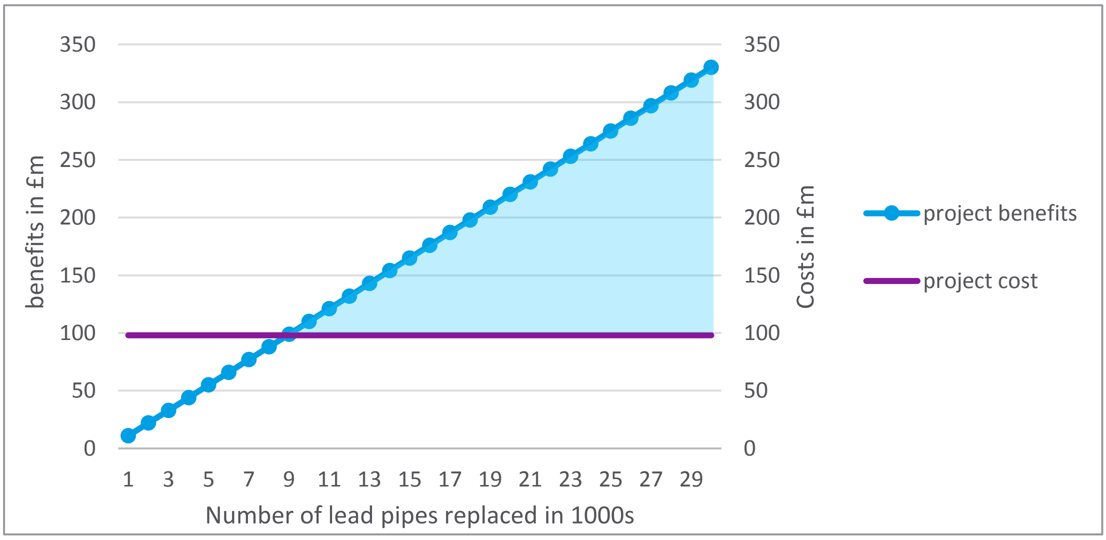
Table 11: Key benefits achieved through supply pipes replacement proposal

Benefits	Qualitative	Quantitative	Estimated % of the costs linked to this benefit
Reduction in public health risk	- Reduced anxiety – 30,000 customers not worrying about debt or health risks - Increased stress due to disruption	£11k/ property (NPV)reduced earning potential resulting from reduced IQ and cost to the health system (primarily linked to childhood behaviour issues) £330m for up to 30,000 properties	90%
Increased water resilience through reduced water demand		£ 2.8m (NPV over 25 years based on WTP for 1Ml/d leakage reduction)	90%
Environmental benefits	Reduced chemical footprint	£0.3m avoided opex and maintenance costs at Bomere Heath	3%
	Increased biodiversity	not quantified carbon benefits net to zero	<2%
Economic benefits – jobs	c.240 jobs	£4.5m avoided cost of 240 unemployed people	1%
Social benefits	Community cohesion/ engagement	Not quantified	0%
Total		£338m	

This equates to a total benefit valuation of £338m and equates to a **benefit: cost ratio of 3.4**.

The health benefits are by far the most material benefit and given the degree of uncertainty about the exact number of pipes we will identify that are lead, the figure below sets out basic sensitivity analysis which shows that if 9,000 or more of the total 30,000 pipes are made of lead (shown by the shaded area) then the total project is still cost beneficial. Given the analysis we have done to target areas where evidence suggests we will find a much higher proportion of lead pipes and the technology that we will be deploying to increase our ability to detect lead pipes we expect that the cost benefit ratio will be between 2.5 and 3.0.

Figure 40: Sensitivity of costs and benefits



5.1 Reduction in public health risk

There is a strong moral argument for removing lead from the drinking water system to protect customers, particularly young children. The World Health Organisation published guidance stating there is no safe level of lead. The direct benefits of having a lead-free supply will be to reduce the long-term cumulative impacts of lead on the body, and well as removing the disadvantage it gives to children's development. This is estimated to be a difference of up to three IQ points, which is assessed as significant at a population level, and disproportionately affects children from lower socio-economic backgrounds. The reduction in long-term cumulative illnesses such as kidney damage and gastrointestinal symptoms could translate into overall disease reduction. There would also be a reduction in health issues including hypertension, irritability, tiredness, headaches and joint pains, leading to a better quality of life.

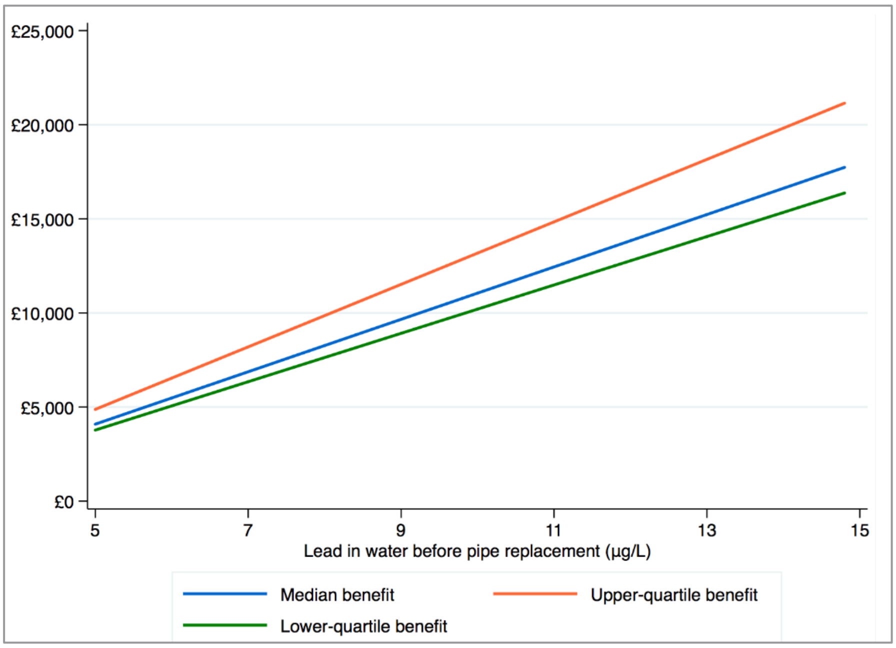
It is not possible to gather willingness to pay values for such an emotive issue. We have therefore focused on identifying evidence that connects the presence of lead in drinking water to financial costs of the following factors:

- reduced earning potential resulting from reduced IQ.
- cost to healthcare system.
- Cost to the education system
- Quality adjusted life years (QALYs)

We have drawn on two key pieces of research; Health Impact project (2017 then updated in 2018) "10 policies to prevent and respond to childhood lead exposure"; and Oxera's study from 1997 which estimated the costs and benefits associated with changes in lead standards for drinking water.

Details of these reports and how we have used the findings to establish the likely benefits for our customers are included in appendix 2. The key findings are shown in figure 41 and based on the median benefit, and assuming that despite the presence of lead pipe the treatment process ensures lead exposure is no higher than 10ug/l (the current standard), we estimate that the financial benefit of removing the lead risk is £11,000 per property.

Figure 41: Gross benefit per lead supply pipe replaced



Other health related benefits

Initial findings in the latest research commissioned by the DWI, expected to be published shortly, shows that there are also measurable adult health benefits associated with reduced kidney and heart disease. We do not have any data to allow these benefits to be quantified, but clearly they would increase the ratio.

Looking at the insights we have gained through our customer research, it is clear that this is a material source of worry for customers once they are aware of the problem. It is difficult to quantify the benefit of removing this worry. As discussed in *Annex 07 Wellbeing benefits*, research shows that there is a strong link between debt and mental health – with 50% of people with any debt at all having some sort of mental health disorder[22]. Prioritising financially vulnerable customers is the right thing to do and is congruent with the Government's 'levelling up' agenda, which aims reduce inequality.

We will unlock additional benefits in support of vulnerable customers through the engagement process. During the course of the work, we can spread the word about our support for vulnerable customers through our social tariffs and the Severn Trent Trust Fund.

There is the possibility that this proposal creates negative benefits during the construction phase of the work. As described in section 1, concerns about disruption is one of the main barriers to customers taking action. This includes the inconvenience of excavating gardens or driveways, and roadworks or parking restrictions that may be required to manage traffic during the works. We will address this by better understanding local concerns, developing communication plans for customers and seeking innovative techniques to reduce or avoid disruption (as set out in section 3.1). While it is difficult to quantify these disbenefits, it is possible they can be balanced against the positive benefits of reduced anxiety about cost or negative health impact of having a lead pipe.

5.2 Increased water resilience through reduced water demand

One of the benefits of taking care of customer supplies is the reduction in leakage and demand created by the additional meter penetration. We have estimated the benefits based on our assumptions around the proportion of pipes we expect to be leaking and average leakage volumes on typical small diameter pipes:

- Replacing a leaking pipe results in 32 l/day benefit – assuming 50% of the pipes are leaking results in 480,000 l/day.
- Installing a water meter drives a potential 20 l/day benefit through reduced demand and faster identification of leakage – based on the meter penetration rates in the three locations (which varies between 39% in Coventry to 58% in Worcester), we have estimated that we can reduce demand by a further 450,000 l/day.

This gives a combined benefit of 930,000 l/day. Using PR19 willingness to pay data, discounted over a 25 year period this translates into a £2.8m benefit.

[22] Jenkins, R., Fitch, C., Hurlston, M. and Walker, F. (2009) Recession, debt and mental health: challenges and solutions. Mental Health in Family Medicine, Vol. 6 (8) pp. 85-90.

5.3 Environmental benefits

Through the Bomere Heath trial, we will be attempting to get 100% uptake rate to enable disengagement of the phosphate dosing at the local treatment works. Across the whole company we currently use 3,000 tonnes of phosphate chemicals, at a significant cost of [redacted] per year. Phosphate chemical costs have been very volatile, with unit costs increasing 30% in the last three years. There have also been periods of scarcity, such as the shortage in 2008. The industry's reliance on continuous dosing is therefore unsustainable.

If we were able to stop all phosphate dosing for lead across our whole company, then the carbon footprint associated with chemical use would reduce by approximately 8-9%.

The reduction in chemical costs at Bomere Heath WTW is unlikely to be seen during AMP7, and therefore the saving will only be apparent when prices are next reset at PR24. However, we estimate the costs of phosphate dosing for this community of more than 1,000 properties [redacted] per year, plus the potential to not need to replace the phosphate dosing rig in AMP8 at a cost of [redacted], which has been added to the benefits of this case for completeness although it doesn't materially impact the result. The real benefits are much greater than this, as we learn how to push uptake rates to 100% to enable this withdrawal across our region.

We are also targeting a relatively small increase in biodiversity. As part of the reinstatement following supply pipe replacement, we will offer customers trees, plants and wildflowers to enhance their garden or outside space, following the disruption. This will enhance local biodiversity in their immediate environment, encouraging pollinators and a range of other insects and birds, creating habitats for them to thrive. Representing less than 2% of overall costs, even small actions can make a big impact on the local environment, as shown by the mock-up of an 'after' image of a street in Coventry that will be part of trial 1 (Figure 42). It also offers a positive permanent reminder of the work, increasing the impact and longevity of education messages communicated during the work.

Figure 42: 'Before' photo and 'after' visualisation following planting of new vegetation

There is potential for collaborative working with the council for street planting as well, and wider community planting/allotments. We have not included any costs or benefits for this as we do not yet have confirmed commitment from the council to contribute to this initiative. We will pursue it through the delivery phase.

In relation to the other benefits this is small, but there are many compounding benefits that are linked to greener streets on health and well-being, traffic calming and air quality. We have not quantified these benefits as part of the cost benefit analysis as they are uncertain and unlikely to be material in comparison to the primary health and water saving benefits. More detail is provided in *Annex 07 Wellbeing benefits*.

Carbon benefit

We have calculated the carbon impact of the activity (embodied carbon) at 729tCO_2e and compared it to the carbon saving through reduced water demand (66 tCO_2e per year), which shows that this proposal would be net-zero after 12 years. After which this investment would make a climate positive contribution for the remaining life of the new pipes. In addition to that, we have made an allowance for customers to choose from offerings such as water butts or trees as part of the rebuild. We would need around 2000 trees to offset the full embodied carbon which is likely to be achieved across the 30,000 customers. This means that this proposal is likely to be net-zero within the delivery timeframe and offer climate positive benefits much sooner than 12 years.

More detail on our approach to ensure all of our proposals have a net-zero carbon impact can be found in Annex 06 Net Zero Carbon.

5.4 Economic benefits: job creation and skills development

The scale of this proposal requires a change in resource, competencies and skills. As described throughout this proposal, we plan to deliver this activity through different delivery models. We will deliver some in-house, creating jobs directly and expanding delivery teams and expertise. Some of the work will be delivered externally, creating additional jobs through our specialist contractors, and other work will be delivered by stimulating the market for approved plumbers to replace supply pipes (using customer grants). We will expand the necessary technical skills for new innovative approaches, as well as vital customer-focused skills, to enable us to educate, inform and engage customers in a different way for proactive supply pipe replacement. Using a mixture of these proposed delivery options will enable us to deliver positive outcomes rapidly.

Boosting skills plays an essential role in making our workforce more resilient to change and improving customer service and satisfaction. The Severn Trent Academy in Coventry is open for in house training from February 2021, but is planned to open its doors to external partners in May 2021, with an emphasis on promoting technical training and customer skills development. The Academy has outdoor training areas with pipework set up for practical training, as well as classroom areas and interactive display boards. We will use the Academy to host training for not just our own water network technicians, but will also look to fill skills gaps for third parties in the delivery models where we will be managing independent plumbers on behalf of our customers, including promoting the Severn Trent Watermark Scheme and National Watersafe Scheme.

We also have established partnerships with local training colleges that we utilise for NVQ training and apprenticeship training. For this proposal, we will aim to mirror the successes of our existing apprenticeship programme, bringing on board 18 new apprentices, 14 as water technician apprentices, to gain a mix of skills to support and enhance existing skill sets for pipe replacement. We will also recruit four plumbing apprentices, who will learn their skills within our Water Regulations and Fittings team and alongside our contractors with plumbing expertise, to develop the new expertise needed for customer side pipe connections.

Overall these proposals aim to create more than 240 roles directly, plus an equivalent number through stimulating work for existing and new supply chain support functions, as we upscale our ways of working to meet this challenge (see Table 12). This will take place through the three delivery models (in-house, contractor and customer grant).

Table 12: We will create over 240 new jobs through the supply pipe replacement programme

STW job creation:	Wider job creation:
31 gangs (in house model) = 62 FTE	31 gang equiv (contractor model) = 62 FTE
8 gangs (grant model) = 16 FTE	16 plumber equiv (grant model)
12 Customer Design Engineers (in house)	3 community landscapers (short term contractor)
3 Comms FTE (all models)	12 Customer Design Engineer equiv (contractor model)
14 support roles (in house)	24 plumbing contractor jobs (in house model)
4 support roles Grant scheme & VFT FTE (grant model)	
18 Apprentices (14 Network, 4 plumbing)	
Total – 129 jobs	**Total – At least 117 job equivalents**

The new jobs include 3 roles enhancing our existing customer engagement activities as we significantly ramp up our customer engagement proposals and 14 support roles, from customer service support to manage the essential customer uptake of this proposal to the increase in Planning and Scheduling to build and coordinate the work. A new team of 62 delivery technicians will be created, who will mentor the 14 water technician apprentices. We will create a new team of 12 Customer Design Engineers to visit each property signed up for supply pipe replacement scheme to explain the route of the supply pipe replacement and agree details such as the point of entry to the property, access agreements to private land, metering and if the customer is happy for us to formally adopt the supply pipe.

There is anticipated to be an equivalent uplift in contractor roles, as work is also packaged and put out for tender to ensure the pace of delivery is maintained – both for replacement of supply pipes and plumbing connection aspects of the work. Watersafe plumbers will also benefit from the generation of work in the trial areas through grants offered to customers for the replacement of their supply pipes. This will also support expansion of our Virtual Field Team, which manages the free new connection process for lead supply pipe replacement, and an increase in the number of network gangs to deliver this.

To value this benefit we have drawn on data that calculates the cost on unemployment on the national purse, which has been estimated at £6243 per unemployed person/ year[23]. Assuming the majority of jobs will be in place for 3 years (some will be in place for 4 years), this equates to a total of £4.5m.

5.5 Social benefits through community education and cohesion

While this work is intrusive to our customers' lives, this does mean it is a great opportunity for impactful communication. We will use this opportunity to extend our education programmes for children and adults to learn about their water supply and extend to water saving opportunities.

As part of the reinstatement following supply pipe replacement, we will offer customer a water butt or other water-saving devices to further enhance the potential water saving benefit. We have not quantified these benefits as they are likely to be small compared to the primary health and wider water demand reductions offered through leakage and metering.

Through the delivery model of maximising the community engagement to leverage peer persuasion between neighbours, there is also potential for the community coming together to improve their street/water supply network collectively. We have not quantified the benefits, but this is something we propose to gather data on to understand the extent to which it alters take-up rates and to better quantify the benefits.

[23] https://www.economicshelp.org/macroeconomics/unemployment/costs/

6. Robustness and efficiency of costs

6.1 Cost robustness

6.1.1 Cost Summary

The expected cost of delivering this proposal is **£98m in total**.

The key components of the cost breakdown are:

- **[redacted] to replace 30,000 customer pipes**. This includes trialling 4,000 joint supply pipe separation and 4,000 complex plumbing configuration, as well as replacing the 30,000 supply pipes and communication pipes (with some communication pipe replacement costs removed for synergies with mains renewal activities in two DMAs). It also includes standard meters for the Worcester and Bomere Heath trials (but not for the Coventry trial, which will be covered by the synergy with the smart metering Green Recovery Business Case proposal).
- **[redacted] of wider initiatives to unlock further benefits**. For example, installing water butts, replacing ground surface with permeable surfaces where communities also have flood risk or suffer from surface water flooding, and tree community planting as part of the reinstatement. [redacted] per property for the 30,000 supply pipes has been allocated for this and includes tree planting to offset the small carbon impact of this proposal.
- **[redacted] on detecting lead**. This is primarily for lead sampling and analysis, to ensure we prioritise lead pipes to maximise health improvement, including some post-replacement verification samples to demonstrate the benefits. The unit cost for sampling and analysis is [redacted] per sample.
- **[redacted] for innovation trials to test technology**. We will gather data and evidence from trialling innovative techniques in detection and supply pipe replacement to drive costs down and benefits up.
- **[redacted] for customer and community education and engagement**. This will engage customers in the subject and provide support throughout the project. It includes costs for digital tools such as a new community App [redacted] and development of a webpage which will act as a customer hub [redacted] as well as family-friendly community-based education and engagement events [redacted], proactive customer communication team [redacted], plus more than [redacted] for leaflets, community posters, newspaper adverts and social media communications.
- **[redacted] for training and developing skills** for newly created posts and where the trial includes working with self-employed plumbers who are bidding to deliver this activity and taking on apprentices.
- **[redacted] for improvements to data capture and sharing system** which can be used by the wider community to support a full roll-out in future.

Figure 43 provides a summary percentage breakdown of costs by activity

Figure 43: Percentage breakdown of total costs by activity

[redacted]

This overall cost assumes smart meters will be installed in the Coventry trial area where we replace supply pipes, costed through the Green Recovery metering business case proposal. This is an interdependency, so if that proposal is not accepted, an additional [redacted] would be required by this proposal to deliver a standard AMR metering outcome in its place. (Note: standard AMR meters for installation within Worcester and Bomere Heath trial areas where we replace supply pipes are included within this business case).

6.1.2 Cost derivation

The largest cost by far is the supply pipe replacement activity itself. Estimates have been based on derived data from the market rates of our closest current activity – communication pipe replacement (short and long side comparisons) – from our commercial tender process. While our contractor costs were standardised and fixed across all framework contractors for delivering this activity during AMP5 and AMP6, our PR19 costs were agreed individually with contractors, enabling us to see the range of costs and approaches to delivery and risk that our contractors have taken. We also reviewed the range of actual Severn Trent costs for this activity in AMP6, including the proactive Leicester Lead Communication Pipe Replacement Scheme, and the PR19 Business Plan costs and Financial Determination (FD) costs. The range of costs from each of these sources is shown in the figure 44 below.

Figure 44: Benchmarking unit costs of communication pipe replacement from different sources

[Redacted]

Some benchmarking costs may not be a direct comparison, for example replacing the communication pipe pricing may include boundary box installation and a standard meter as a flat rate. The cost of communication pipe replacement clearly varies depending on the length and complexity of the job, and the above data includes both short communication pipe and long communication pipe lengths (up to 10m or 12m).

A typical Severn Trent cost breakdown of communication pipe replacement is shown in Figure 45, with labour and reinstatement costs usually making up the majority of the cost.

Figure 45: Illustrative costs for communication pipe replacement

[redacted]

There are obvious similarities between the costs of communication pipe replacement and supply pipe replacement – the basic techniques of the pipe replacement activities are the same. However, there are also key differences that need to be considered:

- Supply pipes are, on average, longer than communication pipes.
- They are on customer property rather than in the highway or verges, so third party land agreements are required (unless there is a legal enforcement remit for leakage impact criteria).
- Access to supply pipes can be more restricted than communication pipes, due to extensions and build overs such as porches or conservatories.
- Connection to the internal plumbing in customers' homes can be more complex than typical mains connection. In some cases, rerouting of the connecting internal plumbing may be required if a new point of entry of the pipe into the property is required.
- Supply pipe configurations include joint supplies, where neighbouring properties are supplied from spurs of a shared supply pipe, rather than individual connections to the water main with individual communication pipes.
- If customers permit us to adopt the supply pipe, there are costs associated with the adoption process.
- Boundary boxes are covered by communication pipe replacement, but there is a desire to install groundbreaker boxes for easy access and simpler demarcation of ownership and responsibilities in the supply pipe adoption process where possible.
- Customer expectation for reinstatement within their property curtilage is higher than that for reinstatement works in the street, and there is a greater range of cover material than the typical reinstatement materials of tarmac, grass, gravel and block paving.

There is a clear cost efficiency by undertaking communication pipe replacement and supply pipe replacement at the same time, so this is an activity assumption for estimating costs for this proposal. For water companies that included small trials of supply pipe replacement within their PR19 submissions, the standard cost allowance for supply pipe and communication pipe replacement was capped at £2,000 in the Final Determination. We have therefore used this top down benchmark as a standard baseline approach and reviewed the bottom up cost estimates for standard replacements for all three delivery models. Additional aspects of the pipe replacement activity that fall outside of the bottom up estimates have been separated out for clarity, such as an additional customer visit to discuss point of entry and supply pipe adoption, and are shown in table 14 below.

In order to estimate additional supply pipe replacement cost complexities we have used the experience of our BOPPS (Burst on Private Property) jobs, repairing leaks on customer supply pipes, to work up reasonable estimates some of the additional costs and difficulties that can be encountered when working on customer properties. It was estimated that up to 25% of supply pipe repairs they undertake are considered complex. We have included costs for complex plumbing scenarios, where a new point of entry for the pipe into the property requires the rerouting of internal pipework and potential reinstatement of kitchen cupboard units for 4,000 properties, based on a plumber hourly rate of £80-100 and the length of time to do the job, plus travel time (one day), with [redacted] provision made per property for the 4,000 assumed complex cases, deflated to 2017/18 cost base. This smaller 'trial within a trial' will ensure we deal with a variety of complexities of supply pipe replacement rather than only selecting those at the lower end of the cost range. Groundbreaker boxes for 4,000 properties have also been included, at a unit rate of [redacted] which has been market tested, deflated to 2017/18 cost base prices.

Another complex aspect is the separation of joint supplies during replacement work. This requires additional work to disconnect the customer from the joint supply. This is necessary so that;

- the customer separating only has a single, metered supply;
- their old portion of the joint supply is removed to eliminate risk of future issues of leakage, poor pressure and water quality, and;
- that the levels of service of customers who wish to remain on the joint supply are not disrupted.

Disconnection of the supply is complex as they are often under patios, conservatories at the rear of the property or kitchen floors, and an end cap or ‘T’ piece of new pipe has to be connected to an old, poor condition pipe. In some cases extensive length of pipe may have to be renewed, for example where the pipe is in such poor condition that joining the T piece is problematic (e.g. the existing pipe has insufficient strength) or where access is impossible and a pipe has to be diverted.

We estimate that the base uplift in unit cost from a standard communication and supply pipe replacement is for this additional work (location, excavation, installation of end cap or ‘T’ piece, customer liaison and reinstatement) at [redacted]. We do not undertake this type of work often or at volume so there is some uncertainty over this cost. We have based this cost on work undertaken for PR14.

Table 13: Detailed breakdown of supply pipe replacement costs – baseline costs, plus add on costs

[redacted]

We have derived other costs, such as customer education and engagement initiatives, from current standard or contracted costings, or estimates extrapolated from these, deflated to the 2017/18 (PR19) price base.

6.2 Cost efficiency

In annex A09 Cost efficiency and robustness we provide details of our overall approach to estimating and ensuring efficient costs. It also sets out the findings of the independent review that was carried out on our Green recovery proposals.

By locking in the PR19 efficient costs, which represents around [redacted] of the total costs, it demonstrates that the level of efficiency is equivalent to what would have been assumed at PR19.

6.2.1 Driving down costs through innovation trials and synergies

One of the key outcomes of the large-scale pilot trials is to get a more granular understanding of costs and factors that influence supply pipe replacement, as this is a new activity. This includes the costs and benefits of the different delivery models and how the costs and benefits change when multiple drivers are targeted. We have to get the cost down to make this an affordable problem, so getting a systemised cost collection/reporting process is imperative. Innovation is key to this challenge, and cost efficiencies are sought by trialling less invasive means to replace pipes that are quicker to deliver and that require less reinstatement – the two biggest cost components. This will help us to evaluate the different technologies and innovation being trialled during the delivery of this proposal, and to share information with the industry to support sector learning.

By replacing supply pipes and communication pipes at the same time, there are time and cost efficiencies through joining these activities. By including small cross-over trials links to existing AMP7 mains rehabilitation programme in two DMAs in Coventry, and the Green Recovery metering proposal across Coventry, we will test the potential time and cost efficiencies of these activities. For the mains rehabilitation synergy in two Coventry DMAs, a cost saving of [redacted] has been reduced from the baseline costs (based on an assumption of a 50% uptake rate). We will also identify any restrictions that combining these activities may pose, for example with scheduling and multi-skilled network teams. This proposal enables metering synergy delivery efficiencies across Coventry as meters will be installed during the supply pipe replacement activity. This enables a cost saving of [redacted] from repeat visits, allocated to the Smart metering Green Recovery proposal.

6.2.2 Direct Procurement for Customers (DPC)

We are supportive of the use of Direct Procurement for Customer (DPC) where it benefits customers and have therefore assessed our Green Recovery proposals using the transparent, repeatable framework that we developed at PR19 with KPMG.

Our conclusion is that the proposal for customer supply pipes does not meet the criteria for DPC because it is not sufficiently discrete.

6.3 Third-party contributions

We want to strengthen the collaboration element of this proposal by working with other agencies, including housing associations, councils and insurance companies, which are all stakeholders in the supply pipe challenge:

- **Housing associations**: the housing associations that manage social housing across our trial areas can help ensure we prioritise the customers who are financially vulnerable. These organisations have the details of their housing stock, and have more awareness of the supply pipe material to understand risks so that we can target effectively.

- **Insurance companies**: we have had interest in these proposals from Homeserve and Direct Line Insurance, and are currently scoping partnership opportunities with them. For example, Direct Line covers supply pipe repairs under some home insurance cover, and offers customers the option to pay the difference to upgrade to pipe replacement. This may be more effective, but few customers take this option. The schemes could be promoted for the customers within the trial areas to enable more effective supply pipe replacement. There is also the potential to link in with energy efficient boiler replacement schemes (customers on old lead pipes often struggle to get the flow needed for modern combi boilers, which can be resolved by replacing the pipes).
- **Councils**: as part of the reinstatement work following supply pipe replacement, we are seeking to provide communities with some improvements to their streets. We would look to partner with the councils in the trial areas to consider planting street trees or pavement planters to improve the local environment.
- **Other sponsors for wider benefits**: there is the potential for communities to come together to influence improvements in their locality, e.g. bicycle companies sponsoring provision of bike racks, garden centres supporting creation of a community garden, local wildlife groups creating of wildlife corridors, with initiatives tailored to the needs of the community.

7. Customer protection

For each business case it will be necessary to ensure that it can be integrated into the regulatory framework, so that (i) customers are protected and avoid paying twice for service improvements and (ii) we are appropriately remunerated for successful delivery of the proposals. Our approach to managing these issues is set out in Annex 11 – Customer protections. This chapter explains:

- how we propose to be held accountable to deliver each green recovery proposal, and in turn be remunerated for successful delivery (and includes the description of each new PC we propose to implement this using the PR19 template)
- what overlaps exist across each of our existing suite of PCs and the green recovery schemes how we will adjust for these to avoid any double remuneration;
- how the totex costs sharing should be applied to better protect customers; and
- how the funding of the green recovery proposals could be implemented within the current AMP.

Appendix A: Joint supply pipe leakage challenges

This Appendix discusses the issues of Joint Supply complications and their impact on detecting and fixing leaks on customer supply pipes, and the rationale for requesting an uplift in costs to undertake supply pipe separation for 4,000 properties to replace a representative proportion of these supply pipes within our trial of 30,000.

A significant challenge for leakage and customer supply side leaks is joint supplies. We and our customers face challenges in repairing leaks on private pipework where there are joint supplies – both in identifying the source of the leak and ensuring collaboration across all customers impacted. We need to look at the joint supply issue differently to ensure we can drive a reduction on supply pipe leakage and achieve our leakage ambition. We estimate that on average 35-40% of customers are on a joint supply (this increases 45-50% of unmetered properties with greater confidence, and a dataset that is growing).

Where we or customers identify a leak on a joint supply, we are frequently told by customers that they were not aware they are on a joint supply and find it difficult liaising with their neighbours (whether due to not knowing their neighbours very well, neighbourly disputes or in some cases because the neighbour is rarely in). This causes customers stress and they would like to avoid it. Anecdotally, many customers would like the whole issue managed for them but currently this is not our responsibility and we only have certain legal rights.

We have also found on occasions that some neighbours are not willing to participate in getting the joint supply leak repaired when it is on their property, but the consequence of the leak is affecting their neighbour. A recent example is of a customer whose property is being undermined and damaged by the run-off from a joint supply leak on their neighbours property; we are trying to support the customer, but as it is private pipework we can only provide certain support when a neighbour is refusing us access.

When there is a leak on a joint supply, we are often not able to determine which customers on the joint supply are legally required to ensure the leak is repaired – it is only those customers downstream of the leak who are liable. However, it is often difficult to pinpoint the location of the leak upfront. This therefore makes it complex and confusing for customers and we are often not able to advise on the costs each customer is likely to incur. It becomes even more complex when some customers have insurance cover for leaks on private supply pipework and others do not – different insurance covers different levels of cover. All of this uncertainty causes customers unease and often causes delays in the leak repair.

In these leaking joint supply scenarios, under our Bursts on Private Property (BOPPS) policy, will usually spread the cost of the repair equally across all customers, regardless of their insurance cover. We offer repayment plans for those who need it, and we don't charge customers in vulnerable circumstances, absorbing their costs ourselves.

If a customer on a joint supply has chosen to have their supply split out and laid their own single supply, they may still be impacted by leaks on the joint supply as the original joint supply pipework will still cross their property. They would not be liable for any repair costs if there was a leak on the joint supply but they may be impacted if repair work was needed to be undertaken on their property. We propose to use these Green Recovery proposal trials to test some practical aspects and customer views and inform our thinking on splitting out joint supplies. We need to think differently about customer supply pipes to limit the chance of them leaking, e.g. whether we continue to install boundary boxes at the property boundary or whether we should run pipework straight to the house reduces the number of joints and therefore potential leak points, informing our metering strategy.

We estimate that there are many more than 4,000 joint supply properties within our trial areas, as numbers can be especially high within cities, and also vary with geographic region and age of property build. For the two largest trial areas, this is shown in Table 1 below, showing Coventry is anticipated to have more than twice the number of joint supplies in Worcester.

Table 1: Percentage of properties estimated to have joint supplies from survey work to date

Location	Joint supply estimate
Coventry DMAs	60%
Worcester DMAs	28%

However, due the high uncertainty of costs around separating out joint supplies, this number will provide a good target sample to enable us to review and share data and lessons learned from this process, in order to inform future policy as well as trying to find better solutions that drive cost down.

Appendix B: Evidence to support the valuation of the financial benefit of removing lead pipes

It is well understood that exposure to lead has a detrimental impact on health. That is the case particularly so for young children. The World Health Organisation (2010) discusses the impact on children's health of exposure to lead. It refers to research indicating that exposure to lead in children's early life has consequences on their loss of intelligence, on the shortening of their attention span and on the disruption of their behaviour.[24] The WHO emphasises that there is neurobehavioural damage even for low levels of exposure; there are, as the report states, no "threshold level below which lead causes no injury to the developing human brain".[25]

The view set out by the WHO on the consequences of lead exposure to children's intellectual functions and neuro-behaviour has been echoed by a variety of other bodies and by academics. See for example the annual reports of the UK's "Lead exposure in Children Surveillance System" of Public Health England, or the "Scientific Opinion on Lead in Food" delivered by the European Food Safety Standard Authority in 2013.26 In relation to the effects of even relatively low levels of blood lead levels, Health Impact Project (2017) states that:[27]

> *even much lower levels, between 3 and 5 μg/dL, can lead to neurologic damage, including impaired memory and executive function, which is the ability to plan, remember instructions, and juggle multiple tasks. Such levels can lead to decreased IQ and academic performance and can also cause behavioral problems, such as impulsivity, hyperactivity, and attention disorders. Some studies suggest that lead exposure may also cause conduct disorders, depression, anxiety, and withdrawn behavior—the tendency to avoid the unfamiliar, either people, places, or situations.*

Lead water pipes, and lead from drinking water pipe fittings are one of the important sources through which children are exposed to lead in the UK.[28]

We have sought to examine evidence that quantifies, in monetary terms, the benefits associated with the replacement of lead pipes.

We have focused on analysis that use statistical modelling to quantify how changes in blood lead levels, brought about by the replacement of lead pipes, give rise, through the impact on cognitive ability and behaviour, to benefits associated with changes in lifetime earnings and in quality of life amongst others. Despite the limitations that exist in applying the findings from statistical analysis that has been carried out in a particular setting to our own setting – and we discuss these below – we consider that this route of analysis is the one that provides an estimate which is most focused on what we wish to measure.

[24] World Health Organisation (2010) "Childhood health poisoning", page 12.
[25] World Health Organisation (2010) "Childhood health poisoning", page 12.
[26] Public Health England (2018) "Lead exposure in Children Surveillance System, annual report 2018", and European Food Safety Authority Panel on Contaminants in the Food Chain (CONTAM) (2013) "Scientific Opinion on Lead in Food", available from https://efsa.onlinelibrary.wiley.com/doi/epdf/ 10.2903/j.efsa.2010.1570.
[27] Health Impact Project (2017) "10 policies to prevent and respond to childhood lead exposure", page 8.
[28] Public Health England (2018) "Lead exposure in Children Surveillance System, annual report 2018", page 25.

Statistical analysis of lifetime benefits of replacing lead pipes

One approach that has been taken to quantify the benefits associated with the replacement of lead pipes is to identify the different elements that form part of the chain of causation – from the replacement of lead pipes through to the materialisation of identified benefits – and to seek to quantify (i) each of those elements, and (ii) the strength of the link between each element. Figure 1 illustrates the approach at a high-level.

Figure 1: High-level elements in quantifying benefits of lead pipe replacement

Such an approach is appealing in terms of its logical reasonableness, and in its breaking down of the exercise into separate analytical components (e.g. analysis of impact of lead pipe replacement on blood lead levels; analysis to quantify monetary impact on earnings from improved cognitive ability and behaviour, and so on). The approach relies on extensive data analysis, and statistical and econometric modelling as it pieces together in a coherent and consistent way the different components.

Oxera's study in 1997 for then Department of the Environment Transport and Regions on estimating the costs and benefits associated with changes in lead standards for drinking water was couched in the above terms.[29] More recent examples are Muennig (2009) and the work by the Health Impact Project, (2017, updated in 2018), both of which report on findings relating to the US.[30]

To produce estimates that are of relevance to us we have drawn in particular on the findings of the Health Impact Project, HIP (2017 and 2018) referred to above. The reason for this is three-fold:

- Our review of HIP's work gives us confidence that the work has been thorough and robust.
- Whilst the analysis carried out by HIP is based on American data, we are able to "plug" into HIP's analysis our own values for some (though not all) parameters, so that we can derive estimates which we expect to be closer to capturing the benefits relevant to our project, in our region.
- The analysis is relatively recent.

Where relevant we have plugged in our own values for some of the parameters to better reflect the setting we operate in, for other parameters that is not the case. For some cases, we would not expect this to be a concern, e.g. it is reasonable to expect the impact on cognitive ability and behaviour from decreased blood lead levels to be similar for British and for Americans. For other cases, there will be differences, e.g. on estimates of returns to earnings from education, or on the differences in the socio-

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[29] Oxera (1997) "Cost benefit analysis of reducing lead in drinking water", Final report to the Department of the Environment Transport and the Regions.
[30] Health Impact Project (2017) "10 policies to prevent and respond to childhood lead exposure"; Health Impact Project (2018) "Technical documentation, methods and data sources for ValueofLeadPrevention.org and Altarum's estimates of state-specific lead exposure costs and lead prevention costs and benefits"; and Muennig, P (2009) "The social costs of childhood lead exposure in the post-lead regulation era", Arch Pediatr Adolesc Med. 2009 Sep;163(9):844-9.

economic distribution in different US states compared to that in our region. We acknowledge the limitations that this brings and have mitigated them by doing some sensitivity analysis on the estimates. Lastly, we note that drawing on the earlier Oxera (1997) analysis, which is focused on the UK, provides additional confidence in the result. Although, as noted in this report, it also draws on American data. That is the case, for example, for the estimates on the impact of schooling on wages, of schooling on probability of employment; Oxera acknowledges the limitations of this.31

Drawing on findings by HIP (2017 and 2018)

HIP (2017, updated in 2018) report estimates of the benefits (and costs) associated with different types of initiatives aimed reducing childhood exposure to lead. One type of such initiatives is the replacement of "lead service lines", covering both lead communication and lead supply pipes.

In broad terms, HIP's estimates are of the benefits from the reduced exposure to lead due to the replacement of the lead pipes in a home with a newly born. The analysis estimates the impact of such intervention on the prevented increase in blood lead levels per child (considering too the impact on young and future siblings that, given demographic distribution and trends, such a child might have over the subsequent 10 years) and, flowing from that, the effect of this on (i) earnings, (ii) health savings, (iii) education savings and (iv) quality adjusted life years (QALYs). The benefits associated with future earnings represent the lion's share of the quantified benefits.32

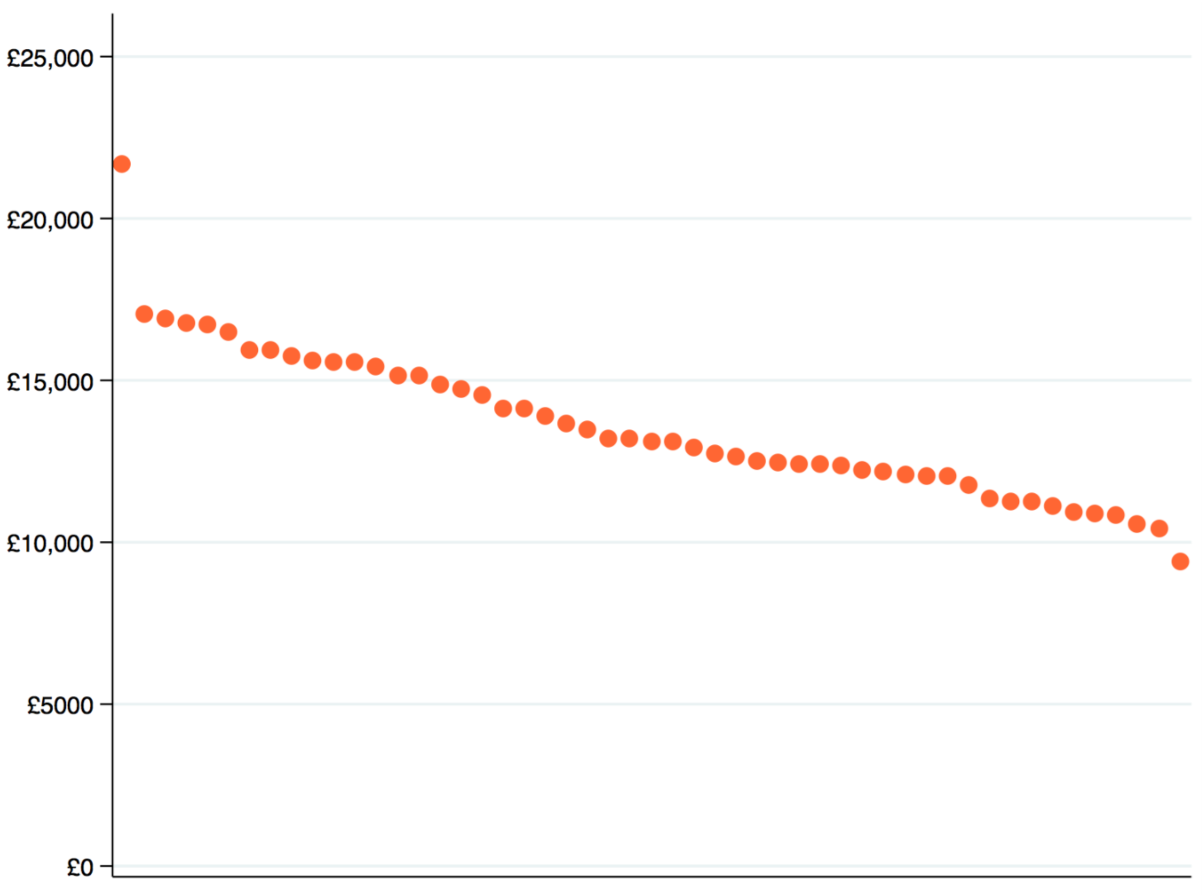
The estimates put forward by HIP rest on an extensive range of elements of analysis: primary analysis of a wide range of datasets of health and socio-economic indicators (including, for example, data on the distribution of blood lead levels in children across the US), as well as reviews of relevant strands of medical and economic literature.33 HIP (2018) sets out a formula underlying the calculation of the benefits associated with the replacement of lead service lines which captures and distils the findings from its analysis.34 HIP uses this formula to calculate the benefits of varying the scale of interventions for each different US state. That calculation ties the estimates of benefits of replacing lead service lines to the following two parameters:

- A "baseline benefit", expressed in money terms, which captures HIP's estimate of a benefit associated with replacing lead pipes for homes where the starting water lead levels is a baseline level of 11.4 µg/L.
- The starting water lead levels for homes whose lead service lines are to be replaced.

From HIP's reporting of its results, we are able to extract estimates of the "baseline benefit", which varies across the US States. The variations reflect the differences in the distribution of socio-economic characteristics, of starting lead blood levels, of labour market characteristics and others. We extract those estimated baseline benefits from the online presentation of HIP's results, which is available from www.valueofleadprevention.org. The distribution of these values is shown in Figure 2, converted from US Dollars to British Sterling using the average exchange rate in 2020.

[31] Oxera (1997), pages 51 and 52.
[32] For a summary of findings see Table 3 in HIP (2018).
[33] See the appendix on methodology set out in HIP (2018).
[34] HIP (2018), page 7.

Figure 1: Distribution of "baseline benefit" across US states



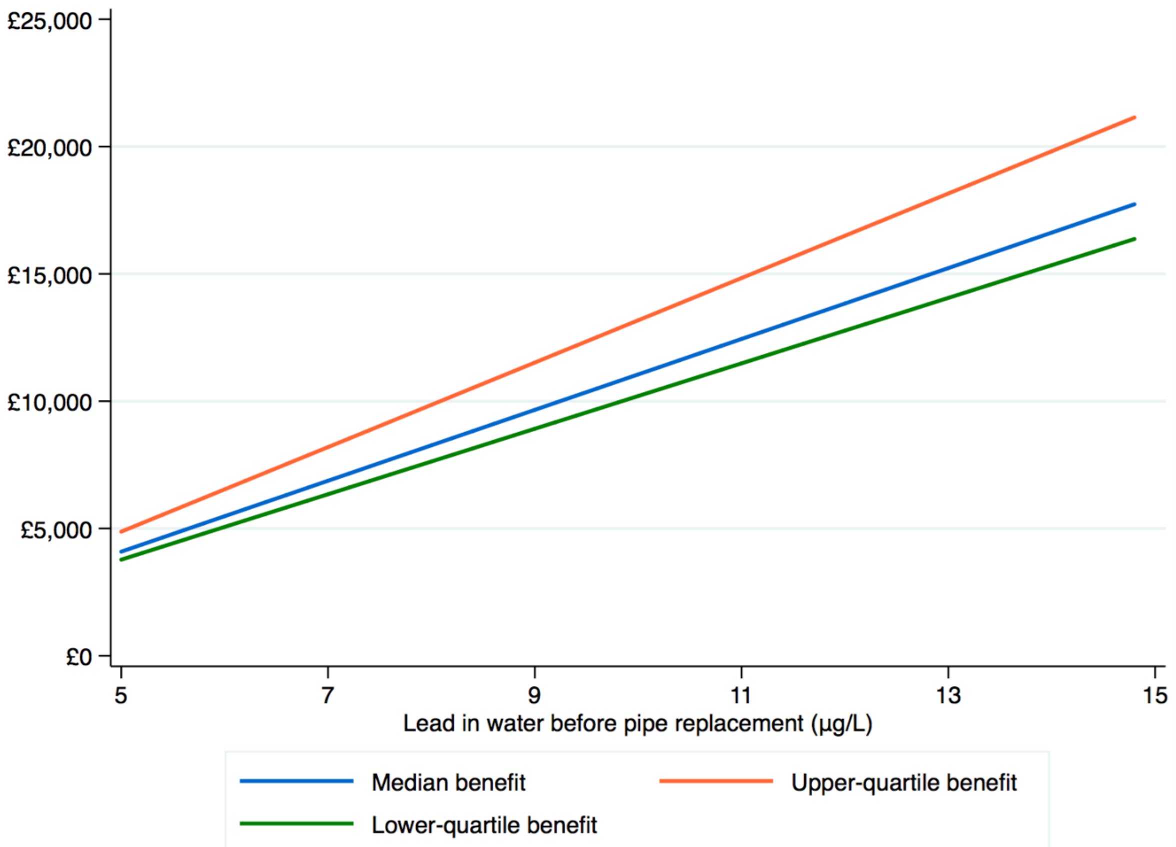
For the purpose of our estimates, given the range of values estimated for the baseline level of benefit, and given the points made earlier regarding the appropriateness of doing some sensitivity analysis around estimates "transplanted" from the American to our context, we will consider a range of values for the baseline benefit. Specifically, we use figures based on the median value of the baseline benefit across the US States, (£13,000), as well as values around the upper-quartile (£15,500) and the lower-quartile (£12,000) of that distribution.

With regard to the second parameter listed earlier, the starting water lead levels in homes whose lead pipes are to be replaced, we also consider a range of values. Specifically, we consider a range of values from 5 µg/L to 15 µg/L. This is centered around the current standard for lead in drinking water in England of 10µg/L, and we would expect homes with lead pipes to be on the upper end of that distribution.

Estimates of benefits associated with replacement of lead pipes

Figure 3 shows the outcome of our analysis, drawing on the work of HIP as set out above. The figure charts the estimate of the benefit associated with replacing lead pipes for the three different levels of "baseline benefit", across a range of values for the level of lead in the drinking water at homes with lead pipes, and which would be candidate for pipe replacement.

Figure 3: Gross benefit per replaced lead service line



Taking the median baseline benefit of £13,000 and assuming, perhaps conservatively, that the level of lead in water in houses with lead pipes prior to replacement is 10 µg /L – the current standard in England –, then, drawing in the findings of HIP as explained above, the estimate of the gross benefit associated with replacing lead pipes would be just over £11,000. The estimate would be £13,200 had we taken the upper-quartile value of the benefit, and £10,200 had we taken the lower-quartile value of that parameter. As illustrated in Figure 3, for any given assumption about the level of baseline benefit, the estimates would be greater for higher starting levels of lead in water.

We are aware of the limitations in the use of results from HIP's work to our context. We noted earlier those that seem most important to bear in mind. Foremost, in this regard is using HIP's estimates of the "baseline benefits" from the US states to the British context. As set out earlier, we have sought to explore this concern by considering a range of values for those baseline benefits. A further point to note in this regard is that, particularly for higher starting levels of lead in water, HIP's analysis shows that the bulk (over 70 per cent) of the benefits arise from the impact on earnings, rather than through savings in health or in education. This mitigates concerns about the differences there might be in the nature and funding of the provision of health care and education between the UK and the US.

Further to these considerations, we also note that HIP's approach, and our analysis based on it, might underestimate in certain respects the overall benefit associated with the replacement of lead pipes. Specifically, HIP's analysis considers the benefits associated with replacing lead pipes in a home with a newly born; it considers the benefits associated with that child, as well as those of any young siblings that it may have or come to have within 10 years. However, the expected asset of life of polyethylene pipes is longer than that of a generation (as set out in the case study in section 3.1.2), and we would expect that the benefits of reduced exposure to lead would continue to be enjoyed by future generations who take up occupancy of the property. The benefit associated with this could be significant, even if the value is discounted back to present values.

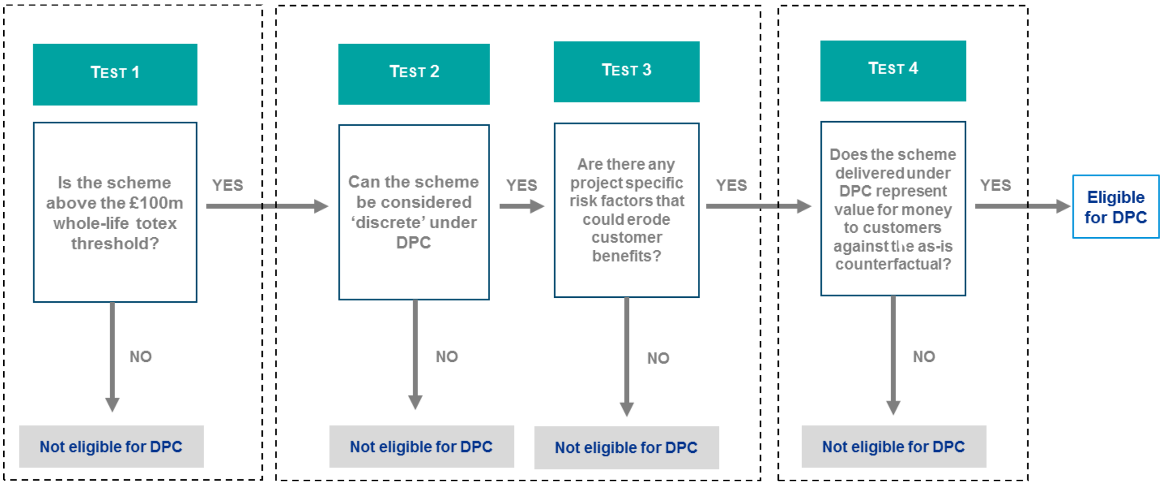
As a further check, we have attempted to cross-check the estimates derived on the basis of HIP with the work of Muennig (2009) and Oxera (1997) which we referred to above and which, like HIP seek to estimate the monetary benefits associated with reduced exposure to lead. Such an exercise, however, is greatly constrained by the differences in the precise thing which the studies seek to estimate. Nevertheless, and for the purpose of providing some context we note that Muennig (2009) estimated that the net benefit to society from reducing lead blood levels to less than 1 µg/dL among all American children between the ages of 0 an 6 would be $50,000 per child. This figure is considerably higher than the estimate derived above, but it relates too to a much sharper fall in lead blood levels than that which would be achieved by the replacement of lead pipes.

Overall we consider our estimate to be reasonable and a central view of the likely benefits.

Appendix C: DPC Approach

Our methodology for assessing whether our capital schemes were potentially suitable for DPC was based on the Ofwat guidance [35] on what constitutes an eligible DPC project, and through the PR19 process was accepted as a reasonable approach. Figure 1 below sets out this four-stage process.

Figure 1: Direct Procurement approach overview



Totex threshold: Due to the compressed timescales of our Green Recovery process we had to run the DPC assessment in parallel with scheme development and selection. In other words, the Totex filtering process started without having certainty over costs or knowing whether they would pass through our cost benefit analysis and so we considered a reasonably wide sample of potential schemes.

Discreteness test: We assessed the extent to which the scheme when operational it is integrated as part of network management and considered the potential implications of third party delivery and operation. We evaluated the schemes against the six criteria developed for the PR19 submission.

The criteria were developed acknowledging the characteristics that Ofwat noted to impact discreteness as shown in figure 2 below.

Figure 2: Discreteness test criteria and considerations

Criteria	*Considerations*
1 Physical asset location	Is the scheme an extension to an existing asset or a new asset constructed on a separate site? Does the asset have its own function or is it highly integrated with SVT's current processes? Does the construction impact the operation of SVTs existing assets?
2 Interfaces	Does the asset have interfaces with SVT's wider network? If so, is it an information or physical interface with one or multiple assets and parties? Are any sensitive information, customer data involved requiring robust security and confidentiality arrangements?
3 Process	For similar type assets are raw material and energy sourced centrally or locally? Is there an automated control over the asset and if so is it run centrally or locally? Are resources shared with the wider SVT's operation? Does the operation require multi-skilled labour? Is the asset an explicit process stage with a clear input and output?
4 Impact on service delivery	Does the service delivery impact SVT's statutory and performance obligations (e.g. ODIs)? If so does it have an impact on quality or reliability metrics? Is the asset part of the water or the wastewater value chain? Does the operation of the asset directly impact customers? Is impact of asset failure well understood?
5 Flexibility	Is the asset's usage likely to change over time? How likely is it that the asset becomes stranded or underutilised over time? Is the asset's operation scalable? Are there alternative usage options for the asset available? Can the operation be easily adapted to changing needs?
6 Control	Is the asset needed for the day-to-day operation? Does the asset have a frequent interaction with the wider network? Is the asset required for resilience purposes? Can the contracting arrangements be designed efficiently and effectively? How comfortable are SVT giving responsibilities for resilience to 3rd parties?

[35] https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Appendix-9-Direct-procurement-FM.pdf

Points are award against each criterion to reflect the level of 'discreteness':

- three where the asset is highly independent;
- two where the asset is partially independent, and;
- one where the asset is highly integrated.

A total score of ten or more indicates the asset may be suitable for DPC. The supply pipe replacement scheme did not pass the discreteness test as it involves multiple sites and an interface with our assets and customers.

Table 1: Discreteness assessment

Criteria	Customer supply pipes	Score
Asset location	Large number of lead pipes highly integrated with SVT's existing assets and network.	1
Interfaces	Significant interfaces required between a number of parties in both construction and maintenance	1
Process	High degree of coordination with wider network and adoption of existing assets required.	1
Impact on service delivery	Asset failure would have significant and direct impact on SVT's customers.	1
Flexibility	Asset has limited alternative, though smart meters may be redeployed.	2
Control	Pipes are passive, but meters require ongoing and frequent coordination with wider SVT network	2
	Total score	**8**

The customer supply pipe proposal is clearly not sufficiently discrete to be delivered by DPC and so the test for project risks and value for money were not completed.