Executive Summary

Context

Whilst compliance with the current 10 µg/L standard for lead is very high, the World Health Organisation's (WHO) Joint Expert Committee on Food Additives (JECFA) and the European Food Safety Authority (EFSA) agree that there is no lower threshold for adverse effects of lead on human health. Adverse health effects from ingestion of drinking water which contains even very small amounts of lead, cannot be ruled out. This evidence has driven the proposed reduction in the lead water quality standard from 10 µg/l to 5 µg/l in the current recast of the EU Drinking Water Directive. It is therefore timely to re-evaluate and compare the remediation costs and health benefits of lead exposure reduction using the latest evidence available.

Method

This study models a number of policy scenarios to understand the costs and benefits of reducing the risk of lead exposure from drinking water in England and Wales over the next 60 years, relative to a reference scenario which broadly describes the current approach to risk mitigation in England and Wales. Each scenario is defined by a lead water quality standard and policy implementation period. Both primary benefits to health and selected secondary benefits from lead service pipe remediation, such as leakage reduction, are quantified.

A risk-based approach to evaluating the costs and benefits associated with policy implementation at a Water Supply Zone level is taken to ensure compatibility with DWI guidance. For modelling purposes, Water Supply Zones (WSZs) are grouped into High-, Medium-, and Low-risk groups using information on historical lead water quality compliance, property type and age, and the level of plumbosolvency control currently applied. 'High-risk' zones are discrete areas of the water supply network in which there is a (relatively) high probability that any consumer could ingest lead from drinking water at a concentration in excess of the water quality standard in force at the time. Key information was provided by a number of water companies, scaled up to a national, England and Wales level. These companies were specifically selected to ensure the economic analysis included a mix of the key features that define lead exposure risk from drinking water.

It is the authors' view that 10 years is a reasonable but minimum timeframe over which water companies could complete the remediation of lead service pipes in high-risk zones, particularly if further preparatory work were started during AMP7. It is possible that further investigation might be required to identify lead pipe locations, and/or some companies may have a higher proportion of high-risk zones. Either could make a 10-year implementation period unfeasible.

We have therefore modelled both a 10-year and 15-year programme of additional remediation over baseline, focussed in high-risk zones, to achieve compliance with a maximum drinking water concentration of **5 µg/l** (i.e. **by 2035 or 2040).** Further remediation is modelled to achieve **no detectable lead by between 2055 and 2070.** The first of these policy options is designed to align with

the present recast of the EU Drinking Water Directive which proposes the adoption of a new lead water quality standard of 5 µg/l within 10 years; the second addresses the overarching objective to minimise lead exposure from drinking water. The costs and benefits of both policy objectives are assessed in a co-ordinated policy timeline such that the 5 µg/l standard is designed to be met by targeting water supply zones deemed high-risk, first.

A key requirement of this study was to quantify the impact of the selected implementation approach on water lead concentrations and hence consumer lead exposure from drinking water. The evidence for reduction in lead exposure from historical controlled trials of lead remediation is mixed. For this reason, both 'conservative' and 'optimistic' water lead exposure profiles are used in the evaluation of health benefits; the former uses lead pipe replacement trial data collated by WRc, and the latter (replacement of all lead to the compliance point results in a 0.2 µg/l maximum water lead concentration) is modelled at Defra's request and consistent with the assumption made in the earlier 1996 DWI study. A midpoint estimate is used to draw conclusions on the relative merit of each policy scenario.

There is sufficient scientific evidence to quantify the adverse human health effects of chronic low-level exposure to lead on neurodevelopment (measured by IQ detriment), cardiovascular disease (CVD: measured by hypertension), and chronic kidney disease (CKD: measured by renal filtration function). These health endpoints were selected as their impact can be valued in terms of lifetime earnings, deaths (mortality) and/or quality of life (morbidity), as appropriate. The inclusion of the valuation of CKD and CVD endpoints significantly advances the utility of the economic analysis from similar earlier studies which focussed primarily on the impact of IQ detriment on lifetime earnings.

Key findings

1. Based on available scientific and practitioner evidence, it is concluded that water companies in England and Wales will be required to replace lead service pipes to guarantee compliance with a lower regulatory standard for lead at the consumer tap of 5 µg/l or lower. Upstream conditioning will need to continue to be used in the interim to control exposure to lead in potable water and is therefore an important component in the economic analysis.

2. Compliance with regulation which mandated the minimisation of lead in drinking water would be extremely difficult, if not impossible, without remediation **up to the compliance point** (normally the kitchen tap).

3. Whilst point-of-entry and point-of-use filter systems and associated consumer education activities are important measures for reducing consumers' exposure to lead, their benefits cannot be guaranteed for the long term. As such, these measures should be considered only as interim solutions that could be deployed in properties known or expected to receive lead concentrations in excess of the lead water quality standard in force.

4. Economic analysis suggests that the choice of a 2035 or 2040 target year to comply with a 5 µg/l standard does not significantly impact upon cost-effectiveness, although it is clear that the 2035 target date for remediation in higher risk zones is more desirable from a public health perspective.

5. For both England and Wales, the most significant components to total benefit components from reduced lead exposure from drinking water, in monetary terms, are (a) avoided reduction in lifetime earnings from IQ detriment, and (b) avoided CKD morbidity and mortality. Other benefits include avoided health impacts from CVD caused by lead exposure, as well as leakage savings and avoided plumbosolvency measures following lead service pipe replacement.

6. The uncertainty assessment in total cost is based solely upon the sensitivity of costs applied to lead pipe replacement based upon a review of unit costs in PR19 business plans and WRc's own assessment of remediation direct costs. Other uncertainties apply but these are judged to be far outweighed by, and potentially accommodated within, the unit cost uncertainty envelope adopted.

7. The uncertainty assessment in total benefits is the sum of the monetised uncertainty in lifetime earnings detriment per IQ point, and the economic impact of the uncertainty in the dose-response relationship for CKD which is derived from alternative estimates of this relationship. The benefits from two different choices of dose-response relationship were taken as upper and lower confidence intervals, and the arithmetic mean benefit taken as the central value.

8. The outcomes of the economic modelling of policy options in England and Wales are particularly sensitive to the choice of post-implementation water lead exposure profile (labelled 'optimistic' and 'conservative'). However, in all cases, the central estimates of benefits and costs, and their upper and lower bounds, have been developed using the best available evidence.

9. Using a midpoint estimate of expected lead concentration profiles in drinking water following remediation, and central estimates of all remediation costs and benefits, the replacement of lead service pipes to the compliance tap in England is highly likely to be cost-beneficial in high-risk zones and likely to be cost-beneficial in medium- and low-risk zones. This assumes high-risk zones are remediated within the first 10 or 15 years of implementation, followed by medium- and low-risk zones up to the end of the policy implementation period.

10. Replacing lead service pipes to the property wall only is not expected to be cost-effective for some low-risk zones in England since remediation costs outweigh health benefits. Health benefits only marginally exceed costs if this remediation option is selected for high- and medium-risk zones.

11. The profile of lead in water concentrations in Wales is currently estimated to be lower than England. This has the effect of lowering the net benefit of lead remediation in Wales relative to England.

12. Lead service pipe replacement to the compliance point in Wales is likely to be cost-neutral or better if the 'optimistic' post policy implementation water lead exposure profile (replacement to the compliance point delivers a maximum lead in water concentration of 0.2 µg/l) is assumed.

13. Replacing lead service pipes to the property wall only cannot be generally recommended as a cost-effective option in Wales as it is less likely to generate sufficient benefit overall.