EXECUTIVE SUMMARY

Purpose of the report
The aim of this study was to investigate the association between drinking water hardness and cardiovascular mortality in areas that had experienced a stepped change in water hardness, calcium or magnesium levels in England and Wales.

Method
Data collection: Mortality data for cardiovascular diseases in England and Wales between 1981 and 2005 were obtained from the Office of National Statistics. Such data included date of death, age at death, gender, cause of death and postcode of last residence. Time series data detailing drinking water concentrations of total hardness, calcium, magnesium and sodium were requested from each company. Concentration data were requested for both pre and post change time periods.

Statistical analyses:
For each area a linear or Poisson regression of log counts on monthly mean maximum daily temperature, its square, the previous months temperature, and variable accounting for the flu epidemic was fitted allowing for a quadratic time trend and the number of days in the month. The change in water hardness was included using an indicator variable. The coefficient of an indicator variable, as with all Poisson regression models, is the risk ratio.

Results
We found no evidence of an association between step changes in drinking water hardness, either increases or decreases, and cardiovascular mortality. We undertook several sensitivity analyses to examine the impact of the model definition and variables upon the results obtained. The results were robust to the inclusion of areal population estimates, the type of model used and the form of the dependent variable. We also undertook a power calculation to examine whether the non significance of the association could be explained by a lack of power of this study to adequately examine the hypothesis.

Only 14 areas were identified in England and Wales that experienced a step change in drinking water hardness over the period 1981 to 2005. Of these, few were areas that had undergone substantial changes with large populations. Overall, drinking water supply
characteristics were mostly stable in England and Wales, particularly with regard to magnesium. As the course of the study progressed, it became apparent that the quality and availability of essential data including water hardness concentration, areal extent and population were variable. This variability could not have been predicted in advance.

**Conclusion**
This study found no evidence of an association between step changes in drinking water hardness, calcium or magnesium and cardiovascular mortality. As we only had one geographical area with a substantial magnesium change, the application of this time series approach in other settings may contribute to the state of knowledge regarding this hypothesis. If the time series approach were to be replicated in other countries and populations, it should only be applied to populations with accurate historical water quality records, mortality and population data.