Research News

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Welcome to DWI Research News

This newsletter is intended to provide a brief summary of recent outputs of the Water Quality and Health evidence programme. The contents section to the right lists the projects covered, and provides useful links to our evidence plan, which lays out the aims and objectives of our research programme, and a quick link to Defra's E-tendering site to register your interest in our future competitions.

Recently published DWI research

Assessing the effect of water meter installation on exposure to lead in water

DWI commissioned a project to investigate the effect of the installation of water meters in lead pipes on the lead concentration in drinking water. It's objectives was to understand the likely impact of the installation of a water meter (or similar fitting), to a property supplied through a lead pipe, and if exposure to lead is increased, to identify possible actions and/or advice to companies and/or consumers to reduce the risk.

The overarching conclusion from this study is that installation of meters or other fittings into lead pipes can lead to transient increases in lead concentration in the water. These elevated concentrations, mainly of particulate lead, can last for about 3 days and can be removed effectively by flushing. Where meters are fitted in lead service pipes water companies should advise consumers of the flushing requirements.

The final report (PDF 2.82MB) is available to download from our website.

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Review of the latest evidence on lead and estimation of intake via drinking water

The objective of the study undertaken by Cranfield University was to update existing data on lead intake from drinking water for consumers living at different property risk groups.

In total, 104 individuals took part in the intake study. The study has shown that lead consumption from drinking water is generally low and is unlikely to have a significant impact on human health when considered in isolation. Only 6 out of 104 individuals were consuming higher lead intakes than the European Food Safety Authority benchmark dose lower confidence limit values. These individuals all lived in properties with lead pipes and no phosphate dosing.

The report concludes that it is prudent to reduce lead intakes by as much as possible where feasible and , given that lead in water is something that can be demonstrably controlled using phosphate dosing, drinking water is an area which can be effectively controlled. This does not obviate the need to employ other strategies to reduce risk.

The final report (PDF 4.47MB) is available to download from our website.

Health Canada Quantitative Microbial Risk Assessment (QMRA) Tool for Two Drinking Water Plants in the UK

This was a jointly funded project to provide an international comparison of the use of the Health Canada QMRA tool. The work was conducted by Corona Environmental Consulting.

The steps involved include conducting an engineering assessment; characterisation of source water pathogen concentrations; and QMRA analyses and risk characterisations.

The findings concluded that the Health Canada tool is well-suited for use in risk assessment and water safety planning for the studied Water Treatment Works. Routine pathogen monitoring would not improve risk estimation significantly at either plant, though monitoring for other purposes could provide benefits. Monthly average process data predicted risks similar to those predicted with daily process data, indicating that the tool framework produces reliable risk estimates. The tool allowed for relatively easy assessment of failure scenarios and produced outputs describing important risk features such as the risk-driving pathogen and the relative contributions of physical removal and chemical disinfection for *Giardia* control.

The findings of this study are generally reassuring, the model suggests the water treatment works studied provide a very high level of protection against the level of pathogens found in the source waters.

Water Companies must continue to follow the regulatory requirements and guidance but the model provides another tool that the companies can use both in their risk assessments and in the event of process failure.

The executive summary (PDF 110KB) is available to download from our website.

Formation of DBPs during Booster Chlorination

Disinfection by-products (DBPs) are formed by the reaction of chemical disinfectants with naturally occurring organic matter and bromide in source waters. The most abundant group of DBPs, the trihalomethanes (THMs), are regulated and measured at consumer taps. All DBPs are subject to the requirement to minimise formation without prejudicing disinfection.

Normal practice in the UK is to maintain a disinfectant residual throughout the distribution system in order to ensure the microbiological quality of the water is not compromised. Typically chemical disinfectants are added to treated drinking water at the treatment works and this is sufficient to maintain a residual up to the consumers' taps. However, where the distribution system is lengthy, it may be necessary

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to add or boost the disinfectant concentration in the network to maintain a residual throughout distribution.

The aim of this project was to understand more about the formation of DBPs, specifically trihalomethanes (THMs) and haloacetic acids (HAAs) in drinking water across England and Wales where the water is subject to booster chlorination. The work was done by Cranfield University.

In agreement with previous researchers it can be concluded that the degradation of HAAs following booster chlorination is a site-specific occurrence, depending on residual chlorine concentrations at various locations in the system and temperature, both of which affect the colonisation of HAA degrading bacteria. Degradation of HAAs was observed in a number of locations whereas THM degradation did not occur to any significant degree

The findings of this study are generally reassuring with only small increases in DBP formation being observed across booster chlorination and over all samples increases were statistically significant for THMs but not for HAAs.

Water companies should consider these findings and make a site specific assessment of DBP formation when adopting any new booster chlorination schemes.

The final report (PDF 6MB) is available to download from our website.

Comparison of Private Water Supply and Public Water Supply Ultraviolet (UV) Systems

The objective of this study was to understand and highlight the critical differences between UV technologies used on public and private supplies and establish the suitability and performance of the most common UV systems used on private supplies.

This study, undertaken by WRc established the range of UV technologies used on public and private supplies in England and Wales, and evaluation the differences in functionality and application. It also reviewed international standards for UV treatment systems to compare validation criteria and identified which criteria would demonstrate suitability for use in private water supplies. Finally it produced simple guidance for householders and local authorities to help in the selection and assessment of UV systems used in private water supplies which is included in the final report.

The report made a number of recommendations to improve the reliability and performance of UV disinfection for private supplies.

The final report (PDF 1.07MB) is available to download from our website.

Pesticide Risk Mapping – Phases I & II

This was a collaborative study with UKWIR as the lead partner and was undertaken by ADAS.

Certain pesticides used in farming may be present in surface and ground waters, and are difficult to remove by existing potable water treatment processes. Catchment interventions are an important and sustainable means of mitigating this risk to drinking water quality.

Phase 1 of this project resulted in the production of intrinsic pesticide risk maps describing diffuse agricultural losses to surface and groundwaters of (i)mobile herbicides herbicides used on arable and grassland and (ii)metaldehyde used on arable land, following the development of an agreement on a consistent risk mapping and catchment intervention approach. This risk mapping approach underpinned by the individual physical properties of a site (such as soil type, drain status, slope, climate, land use, connectivity to surface water and groundwater) was used to derive UK wide course scale risk mas as well as field scale maps for example drinking water catchments.

Phase 2 of the project addressed the need for comprehensive risk mapping coverage at the field scale for all drinking water catchments and the production of software tools to facilitate its use.

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Many obstacles in the form of data availability and regulation were encountered as well as difficulties in determining a set of catchment boundaries across the country (due to data licensing, security, dataset availability and inconsistent data issues).

However notwithstanding these difficulties pesticide risk maps for mobile herbicides (applied to arable and grassland) and metaldehyde (Applied to arable land only) covering much of the UK at a field level have been developed using reasonably consistent datasets. These have been incorporated into software tools to allow the use of these risk maps in both a planning and operational sense.

An accompanying survey of intervention effectiveness studies/trials within this AMP period allowed for the potential to improve default values built into the software as well as promote awareness of activities within the industry.

We believe that the tool may have multiple uses (provided organisations have appropriate software licences), including:

- Company and farmer identification, at field level, of high risk fields to enable appropriate application of pesticides and/or fertilisers
- Company identification of high risk fields for risk assessments for public supplies
- Local authority identification of high risk fields for risk assessments for private supplies.

The Executive summaries of Phase I (PDF 191KB) and Phase II (PDF 184KB) is available to download from our website. The full reports are available from UKWIR, and the QuickCalc Risk Calculator is free to download

Brass Fittings – a source of Lead & Nickel in drinking water

This was the third stage of a UKWIR study, to which DWI contributed, on metals leaching from brass fitting. The report presents the findings of long-term experiments undertaken to determine the leaching behaviour of lead, nickel and other metals of interest (copper, zinc, iron, aluminium and manganese) from various brass fittings in hard/soft, phosphate dosed/non-phosphate dosed waters.

The overall objectives of Stage 3 were:

a) To improve understanding of the long term leaching behaviour of lead and nickel from the brass fittings (by continuing to operate and sample test rigs from April 2015 to March 2016).

b) To improve understanding of the seasonal leaching behaviour of lead and nickel relating to changes in water temperature.

c) To examine the leaching behaviour from brass fittings of other metals of interest such as copper, zinc, aluminium, iron and manganese.

This study has:

- Increased our understanding of how brass fittings may contribute to lead and nickel concentrations in drinking water;
- Assessed the likely impact that brass fittings may have if plumbosolvency treatment is removed;
- Assisted in future assessments of the potential risks to lead and nickel compliance from brass fittings; and
- Provided information to better inform and improve investigations carried out by water companies following failures due to lead (or nickel) standards or carry out other risk assessments related to lead levels in drinking water.

The executive summaries of all three stages are available from our website: Summary report DW04/16 (PDF 226KB); Summary report DW04/17 (PDF 227KB); Summary report DW04/19 (PDF 211KB). The final report is available from UKWIR website.

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Measurement of ptaquiloside concentrations at a few of the most vulnerable sources and final waters

The purpose of this study, undertaken by FERA, was to characterise better the risk that ptaquiloside may pose to drinking water through conducting monitoring at a few high risk sites and so increase our knowledge of levels of ptaquiloside in water. It built upon work undertaken in the previous study (DWI 70/2/237).

Eight monitoring sites were identified that were deemed to be high risk based on bracken coverage and proximity of the abstraction point to bracken.

Samples of the raw and treated water were taken on a monthly basis. The sites included 3 reservoirs and a river (public water supplies) and 4 springs (private supplies), one of which was influenced by surface runoff. In addition to the monthly sampling, samples were taken from one of the feeder streams of a reservoir during 3 rain events.

Samples were analysed for ptaquiloside (PTA) and its degradation product, pterosin B (PTB). The analytical lower limit of quantification of 0.05 µg/L.

No PTA or PTB was detected in the water supplies.

Ptaquiloside was detected in the feeder stream to one of the reservoirs, with concentrations ranging from < 0.05 µg/L to 0.35 µg/L following rainfall events. This feeder stream was not representative of the water quality in the reservoir as a whole.

The results provide reassuring evidence that, even at the worst case sites, no ptaquiloside or pterosin B could be detected in treated water. Exposure is orders of magnitude below the estimates made in the previous study and can reasonably be concluded to be as low as reasonably practicable. Therefore no specific action is recommended for water suppliers or owners of private supplies.

The final report (PDF 670KB) can be downloaded from our website.

Cryptosporidium Genotyping Workshop and Round Robin

The objectives of the project were to provide technology transfer to partner laboratories through a hands-on training workshop, and to evaluate method performance through international multi-laboratory trials. This project was primarily funded by the Water Research Foundation (WRF) in the US with DWI providing a small amount of co-funding.

This project clearly demonstrated that the Cryptosporidium slide genotyping method from a previous project (#4099) could be transferred to potential end-users, including laboratories with limited or no prior experience with molecular methods. Although the use of a real-time PCR instrument is recommended due to the additional information that high resolution melt (HRM) analysis provides, the method was shown to be compatible with conventional PCR instruments as well. The slide genotyping method also had a comparable success rate to other more complicated and cumbersome multi-step nested PCR restriction fragment length polymorphism (RFLP) protocols used in previous studies.

This project has confirmed that the slide genotyping method can be transferred to laboratories with limited prior experience of molecular methods.

The Executive Summary (PDF 542KB) can be downloaded from our website, with the full report available from WRF.

Fate of Non-Regulated Disinfection By-Products in Distribution Systems

Again this project was primarily funded by WRF in the US with DWI providing a small amount of co-funding.

The objective of this study was to investigate the formation and degradation (both chemical and biological) of key non-regulated disinfection by-products of potential human health concern in drinking water distribution systems. This work was conducted through both laboratory studies and field sampling events.

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Thirteen intensive sampling campaigns were conducted at the 11 participating utilities for DBPs. Each utility was sampled at least once. Two utilities were sampled twice. The utilities also provided water ages for each location. Hydrant flush samples were collected from each utility for testing for the presence of bacteria capable of biodegrading various halogenated DBPs.

Results indicated that concentrations of most unregulated DBPs were highly variable between different utilities and even within a single system. There were no reliable or universal relationships between the regulated DBPs (THMs and HAAs) and the nonregulated compounds. However, there were patterns that could be identified based on residual disinfectant type, pH, and treatment, especially the use of strong oxidants and long free chlorine contact times for systems using chloramines.

Most water systems have bacteria with dehalogenase genes that are capable of biodegrading a wide range of DBPs. Proliferation of these organisms to the point that they actually depress DBP levels in the system is less common. Many non-regulated DBPs are subject to alkaline hydrolysis and abiotic degradation. Stability of these compounds in actual distribution systems is often greater than expected from simple laboratory experiments.

The main finding of the research is that there is no single set of recommendations for distribution system operation and management that will minimise all DBPs. Existing guidance in for England and Wales recognises that minimisation need to be site specific, dependent on the treatment and distribution system and gives advice on minimisation. It is not considered necessary to revise the guidance in light of this research.

The Executive Summary (PDF 604KB) is available from our website, with the full report from WRF

Investigation of the potential formation of 2,4-D from fluoranthene

This was created to understand whether and under what conditions the pesticide 2,4-dichlorophenoxyacetic acid, commonly known as 2,4-D can be formed as a disinfection by product in water distribution systems. It was undertaken by Cranfield University.

The analysis indicated there was no 2,4-D formed in the untreated water from any of the methodologies applied. The compounds added to the water samples showed some degradation from the initial value with a corresponding reduction in chlorine. However no formation of 2,4-D was apparent, with levels remaining below the limit of detection of 0.026 µg/L in all cases. No other acid herbicides were found nor any semi-volatile organic compounds other than those added (PAHs and dibenzofuran). The exact conditions to form 2,4D could not be reproduced during the experimental phase. It is believed that a microbial step is required, so further investigation should focus on taking non-sterilised sample from the distribution system where 2,4-D has been detected after the company have re-laid a new piping system and it has been installed for a few months to recreate the environment necessary to form the compound.

It has been hypothesised that 2,4-D is being formed as a DBP by the reaction of residual chlorine with fluoranthene. This transformation may involve microbial processes. Whilst no mechanism has been identified, a number of possible intermediates, such as phenol, and o- and p-hydroxybenzoic acids have been postulated.

The full report (PDF 345KB) is available to download from our website.

A review of risks to drinking water quality at rural public buildings in England and Wales.

The aim of this project was to confirm whether or not there has been a bias towards sampling of urban versus rural public buildings. The intention was also to understand what contamination risks (chemical, aesthetic and microbiological) are associated with drinking water quality supplied to rural public buildings, and to assess their significance on “wholesomeness” and impact on consumers. The project also aimed to determine whether the existing guidance for persons in control

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of water supply arrangements for such premises is adequate, and to recommend how future standard guidance could be best produced and disseminated. The project was conducted by WRc.

The rural public buildings analysis demonstrated that the classification of public buildings is not consistent between water companies. It showed that there is some evidence that water companies are not sampling rural public buildings as frequently as their urban counterparts, but it was not possible to identify any statistically robust conclusions on the difference of water quality compliance between urban and rural public buildings due to the very low number of reported failures.

Potential chemical contaminants that may be more likely to occur in drinking water supplying rural public buildings were identified. Some of these are likely to be present as a result of the age and quality of pipework and fittings used in these types of buildings (e.g. copper, nickel, iron, aluminium or lead), as well as intermittent use of supply (stagnation of water and increased potential of leaching). Other contaminants may include hydrocarbons following spills of heating oil, petrol/diesel or the use of coal-tar pitch linings in older pipework, plasticisers from plastic pipes, which can potentially leach into water, and also disinfection by-products or compounds of microbial origin (geosmin and 2-methylisoborneol (MIB), which could lead to taste and odour problems. Another factor related to rural public buildings, which was considered as giving increased potential for risk of microbiological contamination, was their location on remote sections of a distribution system.

The review of existing guidance for those in control of rural public buildings revealed that only a few guidance documents are available and none are specifically on water supply systems. Inconsistencies were also identified on the available guidance from water companies and Water Regulations Advisory Scheme (WRAS) about the length of time stagnant water may cause aesthetic and/or health problems from the drinking water.

In terms of how future standard guidance could be best produced and disseminated, it was suggested that a Steering Group, comprising representatives from the water industry (with expert input on drinking water quality and communications) with a small set of representatives from the target audience, or their umbrella bodies is set up to agree the technical content of the guidance and drive the process. The guidance can then be developed and the contents and format consulted on, and the guidance then disseminated. A questionnaire question 'indicated that most of the respondents did not have a preference to any particular method. The project suggests that the guidance could be published as a free download from the DWI website and its relevance communicated through networks to reach those managing rural public buildings. An umbrella organisation like Water UK could make this available for all water companies to include on their websites and make use of in their own communications with customers.

DWI will be considering the findings and suggestions made and establishing a way forward in a collaborative capacity with water companies to remedy the gaps that this research has identified.

The final report (PDF 1.07MB) is available on our website.

Technical definition of wholesomeness in relation to water used for toilet flushing in private water supplies.

All water supplied in England and Wales by statutory water companies, and which is intended for all domestic purposes, must be wholesome at the time of supply. There is a similar legal requirement for private water supplies. Whilst water for toilet flushing falls within the definition of a domestic purpose, such a supply might not need to be of the same quality as that for other domestic purposes, provided it is used solely for toilet flushing.

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Consequently, the Drinking Water Inspectorate (DWI) for England and Wales commissioned WRc to document the scientific information required to underpin a technical definition of wholesomeness to water from a natural source (e.g. springs or boreholes) used solely for toilet flushing in domestic properties without further preparation or treatment. This investigation takes into consideration public health risks and aesthetic issues, including the possible setting of standards for such a water supply.

The report found that there was no consensus on either a definition of wholesomeness or appropriate guidelines or standards for water sourced naturally and used solely for toilet flushing with further preparation or treatment. There is also a lack of basic research on the risks to human health associated with the use of non-drinking water for toilet flushing.

In the absence of such consensus, a simple risk evaluation approach was developed which could be used by local authorities and individuals or groups of individuals taking account of local conditions. Rather than a methodology based on standards, which would require monitoring, this approach is based on a traditional Source-Pathway-Receptor assessment considering potential microbiological and chemical risks which would exclude use of potential sources where a risk was identified and also further advise on pathways such as pipe fittings and storage. Such a risk evaluation could be considered alongside the extensive advice provided by DWI on private water supplies.

The full report (PDF 1.09MB) is available on our website.

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