SECTION 2

PROPERTIES AND CONTAMINANTS OF WATER

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Private Water Supplies

2.3 Micro-organisms

In the UK a high proportion of outbreaks of **waterborne disease** have been associated with private supplies. *Campylobacter, Cryptosporidium and Giardia* are the most common pathogens associated with private supplies.

Campylobacter: Found in high numbers in the faeces of infected pigs and poultry, and the infective dose in contaminated water is relatively low.

Disinfection through chlorine, ozone and UV at the levels normally applied should ensure no viable *Campylobacter* organisms enter the supply, but waters must first be conditioned adequately by the removal of dissolved organic material and particulates, particularly where UV disinfection is being used.

Cryptosporidium: Cattle, sheep and human sewage are the main sources of contamination of private water supplies. A combination of catchment control, physical barriers and disinfection is required to provide protection from the organism.

Private supplies derived from surface waters and springs will be vulnerable to contamination, particularly in agricultural catchments. Filtration (through coagulation, sedimentation and filtration) is advised to remove *Cryptosporidium*, with disinfection aimed at inactivating any remaining viruses and bacteria.

Giardia: Private supplies should be regarded as being at greater risk if the catchment is prone to contamination by the faeces of animals, if there is a rapid route for recharge to reach the raw water intake and if there are inadequate treatment barriers. Normal coagulation, sedimentation and filtration processes, if operated correctly, should achieve at least a 3-log (99.9%) removal of *giardia* cysts.

E. coli: Many types of *E. coli* bacteria are harmless. The infectious dose of the harmful strain *E. coli* O157 appears to be very low. *E. coli* is used as faecal indicator for other pathogens.

2.4 Chemical Contaminants

Aluminium in raw water can be removed by coagulation and filtration. The national standard is **200 µg/l** and is based on avoiding problems of cloudiness and discolouration rather than being health-based.

Iron and manganese suspensions can reduce the efficiency of chlorine disinfection. Filtration after coagulation, sedimentation and oxidation may be required for when supplies contain more than 1 mg/l of either.

Lead. The current standard is 25 µg/l. By 2013 a new standard of 10 µg/l is to be met. For small water supply systems the best approach is the replacement of lead-containing materials with non-leaded alternatives. If water has been standing in lead pipes overnight, the tap should be run for 60 seconds before taking water for drinking or cooking.

Arsenic. The standard for arsenic is 10 µg/l. Arsenic (V) can be removed effectively by iron or aluminium coagulation. Arsenic (III) requires pre-oxidation (e.g. using chlorine). Other potential removal techniques include ferric oxide, activated alumina, ion-exchange and reverse osmosis.

Ammonia. Even small amounts of **ammonia** (e.g. above 0.05 mg/l NH_4) in groundwater normally warrant further investigations. Ammonia can be removed by aeration (after increasing pH to 11), ion-exchange, biological denitrification and breakpoint chlorination. Chlorine capacity must be sufficient to produce a free chlorine residual. However, only chlorination is likely to be applicable to small supplies.

Pesticides commonly reported include atrazine, simazine dieldrin, isoproturon, mecoprop and chlorotoluron. UK drinking water quality regulations specify standards of 0.1 µg/l for individual pesticides and 0.5 µg/l for total pesticides, though there is no toxicological basis for this. Ozonation, activated carbon adsorption and oxidation processes can reduce pesticide levels, but for small supplies with significant concentrations, an alternative water supply may be necessary.

Chlorinated solvents. The UK standards are 3 µg/l for 1,2-dichloroethane and 10 µg/l for the total of tetrachloroethene and trichloroethene. Solvent concentrations can be reduced by aeration or activated carbon adsorption, the latter being the likely choice for small water supplies, though an alternative supply may prove more economical. Water contaminated by chlorinated solvents can travel large distances, making it difficult to pinpoint the source of pollution.

Trihalomethanes (THMs) are formed as a result of reactions between chlorine and some organic substances present in raw waters. These precursors can be removed to some extent by adsorption on activated carbon, or an alternative to chlorine may be considered. The UK standard is 100 µg/l for the total of THMs present.

Bromate is formed by oxidation of bromide if water is ozonated. It is difficult to remove but its formation can be minimised by limiting the ozonation.

2.5 Physical and Chemical Properties

pH value. UK standards specify a minimum of pH 6.5 and a maximum of pH 10.0. The pH value can be changed by aeration, alkali or acid dosing or contact with alkaline material in contact beds.

Hardness. No UK standards are specified for hardness, calcium or magnesium but the Department of Health has stated that "it remains prudent not to undertake softening of drinking water supplies". Where water is softened by base exchange softening, it is important to provide an unsoftened outlet for potable purposes. Installation of a softener just before the hot water tank or boiler is a more economical way of preventing limescale than softening the whole supply.

Colour is removed for aesthetic reasons but the contaminants causing a high colour can also impair disinfection processes, cause high concentrations of trihalomethanes and foul reverse osmosis membranes.

Colour is expressed in mg/l on the platinum-cobalt (Pt-Co) scale, which is equivalent to Hazen units (˚H). The UK standard is 20 mg/l Pt-Co, but the colour must also be "Acceptable to consumers and [with] no abnormal change".

Colour removal at a water treatment works is usually achieved by coagulation followed by sedimentation or flotation and filtration, though filtration is usually inefficient for small supplies.

Turbidity is removed because it can impair the efficiency of disinfection, and for aesthetic reasons. The UK standards are 1 NTU in water leaving treatment works and 4 NTU at consumers' taps. It must also be "Acceptable to consumers and with no abnormal change".

Rapid sand filtration or microstraining can remove coarse turbidity and some species of algae. Fine turbidity and many species of algae can be removed by slow sand filtration or by coagulation followed by sedimentation or flotation and filtration.

Taste and odour. The intensity of taste and odour is expressed as Dilution Number and the UK standards for both are 3 dilution number at 25 ˚C, with the standard requirement "Acceptable to consumers and with no abnormal change".

Taste and odour are removed principally for aesthetic reasons. They can be reduced or removed by aeration, ozonation or adsorption on activated carbon or, where chlorination is the source, by control of the disinfection process.

Private Water Supplies

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2 PROPERTIES AND CONTAMINANTS OF WATER

2.1 Introduction

Methods used for the treatment of a raw water will depend on the properties of the water and the presence and concentrations of any contaminants. Groundwaters usually have low levels of colour and turbidity and consistent microbiological quality, although water from shallow wells and some springs may be more variable. Particular problems may include high or low pH value and alkalinity and high concentrations of iron, manganese, nitrate, chlorinated solvents or pesticides. Surface waters may have high levels of colour and turbidity and exhibit poor microbiological quality. Quality may be variable and deteriorate following periods of heavy rainfall. Other problems may include low pH value and alkalinity and high concentrations of aluminium, iron, manganese, nitrate or pesticides.