

## **SUMMARY**

### **I BENEFITS**

This report provides a comprehensive review of the inhalation and dermal toxicity data currently available in published literature of the four trihalomethanes (THMs) listed in the national regulations for drinking water in England and Wales (DWI, 2000), namely chloroform, bromoform, bromodichloromethane and chlorodibromomethane. Studies have been summarised and assessed on the basis of their quality. These data have been used to derive acceptable levels of exposure that do not pose significant risk to human health following exposure via these routes.

### **II OBJECTIVES**

The purpose of this report is to review the available toxicity data for the four regulated trihalomethanes (THMs; chloroform, bromoform, bromodichloromethane and chlorodibromomethane) via the inhalation and dermal routes for the derivation of tolerable levels of exposure that do not pose significant risk to human health. These tolerable levels of exposure will be subsequently compared with models that estimate exposure to THMs via the inhalation and dermal routes to assess the adequacy of the current drinking water standard for THMs.

### **III REASONS**

THMs are chemicals formed as by-products of disinfection during drinking water treatment processes. The 1998 European Union Drinking Water Directive (EC, 1998) specified a standard of 100 µg/l for the sum of concentrations of four THMs, namely chloroform, bromoform, bromodichloromethane and chlorodibromomethane. This standard has been transposed into the national regulations for England and Wales (DWI, 2000). In 2005, the World Health Organization (WHO) established Guidelines for Drinking-water Quality (GDWQ) for the individual THMs of 300, 100, 60 and 100 µg/l for chloroform, bromoform, bromodichloromethane and chlorodibromomethane, respectively (WHO, 2005).

The WHO guideline value only considers exposure to THMs in water via the oral route. However, WHO accepts THMs are volatile chemicals, and therefore, exposure via the inhalation and dermal routes may be significant sources of exposure, particularly during bathing and showering, as increasing water temperature will increase the rate of volatilisation, and ventilation may be poor. WHO suggested that in colder countries with low rates of ventilation in houses or where the incidences of showering and bathing are high, this guideline value may be lowered (WHO, 2005).

### **IV CONCLUSIONS**

A substantial body of data is available on the toxicity of chloroform via the inhalation route. Data on the inhalation toxicity of bromoform and bromodichloromethane are very limited and no data on the repeat dose inhalation toxicity of chlorodibromomethane were located.

Data on the toxicity of THMs via the dermal route are limited. No repeat dose dermal toxicity data were located for chloroform, bromoform or chlorodibromomethane. Three repeat dose studies were located for bromodichloromethane. Levels below which adverse health effects would not be anticipated have been derived for each THM via the dermal and inhalation

routes. These levels are referred to in this report as tolerable daily doses. Due to the limitations in the data, route-to-route extrapolations using oral toxicity data and the application of large uncertainty factors to toxicity data have been necessary to derive these tolerable daily doses.

Models have been derived to estimate exposure to individual THMs via the dermal and inhalation route. However, it should be noted that the outputs from these models have a high degree of uncertainty. The models have not been validated but they are precautionary and so probably over-estimate exposure. Each model assumes that all exposure to each THM is from a single route (dermal or inhalation) and biological processes such as metabolism are not taken into consideration.

The models developed suggest that for the dermal route, at individual THM concentrations of 100 µg/l (the standard for total THMs), it is unlikely that an individual will be exposed to a dose at which adverse health effects would be anticipated.

For the inhalation route, at an individual THM concentration of 100 µg/l, the models suggest that it is possible to be exposed to inhaled doses of THMs above the relevant tolerable daily dose. However, these are considered to be extreme exposure scenarios, in part because individual THM concentrations are most unlikely to exceed the standard for the sum of all four THMs. In addition there is a high degree of uncertainty in the data. Therefore, while it is not possible to exclude the possibility of adverse effects occurring at these high exposures, this does not mean that adverse effects will occur.

Using mean concentration data reported for each of the individual THMs in 2000 has allowed the modelling of a more realistic exposure scenario. These data indicate that for most THMs it is most unlikely that an individual will be exposed to a dose above the tolerable daily dose. The exception to this is bromodichloromethane, and even in this case, multiple exposures would be required in the 30-minute bath or 15-minute showers scenarios to exceed the tolerable daily dose. Again, it should be emphasised that while it is not possible to exclude the possibility of adverse effects occurring in these unusual circumstances, due to the large uncertainty with the data, it does not mean that adverse effects will occur.

## **V RECOMMENDATIONS**

Due to the uncertainty in the toxicity data and the exposure models, the risk assessments presented in this report are highly precautionary. When considering the regulation of THMs it is important to consider the combined effect of oral, dermal and inhalation exposure. A crude combined risk assessment has been considered in this report. This crude assessment was based on the results of the highly precautionary toxicity data and exposure models, and is therefore also likely to be highly precautionary. The combined assessment indicates that the drinking water standard may not be sufficiently protective for any of the individual THMs. Again it should be noted that due to the large uncertainty with the data, it does not mean that adverse effects will occur. Given the large uncertainty that currently exists in this risk assessment, it is not currently possible to derive a more robust combined risk assessment. Further investigation of the toxicity and toxicokinetics of THMs via the dermal and inhalation routes would reduce this uncertainty and allow further consideration of the standards for THMs by regulatory authorities to be conducted.