industrial emissions and anthropogenic uses. Food is the primary source of intake for the non-occupationally exposed population. However, where barium concentrations in water are high, drinking-water may contribute significantly to total intake.

Guideline value	1.3 mg/l (1300 µg/l)
Occurrence	Concentrations in drinking-water are generally below 100 µg/l, although concentrations above 1 mg/l have been measured in drinking-water derived from groundwater
TDI	0.21 mg/kg bw per day, derived by applying an uncertainty factor of 300 to account for intraspecies variation (10), interspecies variation (10) and database deficiencies (3 for the lack of a developmental toxicity study) to a $BMDL_{05}$ of 63 mg/kg bw per day for nephropathy in mice in a 2-year study
Limit of detection	0.004–0.8 µg/l by ICP-MS; 1.0 µg/l by ICP-AES
Treatment performance	Ion exchange, lime softening or direct filtration with chemical precipitation may be able to remove barium to below 1 mg/l
Guideline value derivation	
• allocation to water	20% of TDI
• weight	60 kg adult
• consumption	2 litres/day
Additional comments	As rounding can have significant practical implications at milligram per litre levels, it was concluded that a guideline value with two significant figures was reasonable in this case.
	The guideline value derived based on the long-term mouse study is not inconsistent with health-based values that could be derived from limited human studies.
Assessment date	2016
Principal references	IPCS (2001). *Barium and barium compounds* USEPA (2005). Toxicological review of barium and compounds. In support of summary information on the Integrated Risk Information System (IRIS). WHO (2016). *Barium in drinking-water*

There is no evidence that barium is carcinogenic or genotoxic. Acute hypertension has been observed in case reports, but the effects may be secondary to hypokalaemia. The critical study that had been identified previously for deriving the guideline value has several limitations (e.g. no effect observed at the single dose evaluated, limitations in the exposure methodology and design, no control for important risk factors for hypertension). Another human study that reported no effects on hypertension at 10 mg/l is limited by the small study size and short exposure duration. Barium has been shown to cause nephropathy in laboratory animals, and this was selected as the toxicological end-point of concern for the current guideline.

Bentazone

Bentazone (CAS No. 25057-89-0) is a post-emergence herbicide used for selective control of broadleaf weeds and sedges occurring among a variety of crops. It is highly soluble in water and very resistant to hydrolysis; it is also very mobile in soil. However,

photodegradation occurs in both soil and water. Bentazone may leach from soil into groundwater, particularly during heavy rainfall, and may contaminate surface water through effluents from production plants, drainage waters and actual use in the water (rice fields). Exposure from food is likely to be low.

Reason for not establishing a guideline value	Occurs in drinking-water or drinking-water sources at concentrations well below those of health concern
Health-based value*	0.5 mg/l
Acute health-based value**	20 mg/l
Occurrence	Concentrations up to 120 µg/l in groundwater and up to 14 µg/l in surface water have been measured
ADI	0–0.09 mg/kg bw, based on a NOAEL of 9 mg/kg bw per day for prolonged blood coagulation and clinical chemistry changes indicative of effects on liver and kidney from a 2-year toxicity and carcinogenicity study in rats and application of a safety factor of 100
ARfD	0.5 mg/kg bw, based on a NOAEL of 50 mg/kg bw for decreased motor activity observed in male rats on day 0 in an acute neurotoxicity study and application of a safety factor of 100
Limit of detection	0.1 µg/l by GC with ECD after liquid–liquid extraction; limit of quantification of 0.01 µg/l by LC-MS/MS
Treatment performance	Conventional treatment, including coagulation and filtration, not effective; activated carbon may be effective under certain circumstances
Health-based value derivation	
• allocation to water	20% of upper bound of ADI
• weight	60 kg adult
• consumption	2 litres/day
Acute health-based value derivation	
• allocation to water	100% of ARfD (0.5 mg/kg bw)
• weight	60 kg adult
• consumption	2 litres/day
Additional comments	The default allocation factor of 20% has been used to account for the fact that the available food exposure data, which suggest that exposure via this route is low, do not generally include information from developing countries, where exposure via this route may be higher
	As a general principle, the concentration of pesticides in water, including bentazone, should be kept as low as possible and concentrations should not be allowed to increase up to the health-based value.
	Further guidance on interpreting the health-based value and deciding when to monitor can be found in section 8.5.3
Assessment date	2016 and 2020

Principal references	WHO (2013). *Pesticide residues in food – 2012 evaluations* FAO/WHO (2016) *Pesticide residues in food – 2016 evaluations* WHO (2020). *Bentazone in drinking-water*

* When a formal guideline value is not established, a "health-based value" may be determined in order to provide guidance to Member States when there is reason for local concern. Establishing a formal guideline value for such substances may encourage Member States to incorporate a value into their national standards when this may be unnecessary.

** For more information on acute health-based values, see section 8.7.5.

Bentazone is not carcinogenic in rats or mice, and showed no evidence of genotoxicity in a range of in vitro and in vivo assays. Consistent observations in repeated-dose toxicity studies in mice, rats and dogs are effects on haematology and blood coagulation (e.g. prolongation of prothrombin time and partial thromboplastin time).

Benzene

Benzene is used principally in the production of other organic chemicals. It is present in petrol, and vehicular emissions constitute the main source of benzene in the environment. Benzene may be introduced into water by industrial effluents and atmospheric pollution.

Guideline value	0.01 mg/l (10 µg/l)
Occurrence	Concentrations in drinking-water, when present, generally much less than 5 µg/l
Basis of guideline value derivation	Robust linear extrapolation model (because of statistical lack of fit of some of the data with the linearized multistage model) applied to leukaemia and lymphomas in female mice and oral cavity squamous cell carcinomas in male rats in a 2-year gavage study
Limit of detection	0.2 µg/l by GC with photoionization detection and confirmation by MS
Treatment performance	0.01 mg/l should be achievable using GAC or air stripping
Additional comments	Lower end of estimated range of concentrations in drinking-water corresponding to an upper-bound excess lifetime cancer risk of 10^{-5} (10–80 µg/l) corresponds to the estimate derived from data on leukaemia from epidemiological studies involving inhalation exposure, which formed the basis for the previous guideline value. The previous guideline value is therefore retained.
Assessment date	1993
Principal reference	WHO (2003) *Benzene in drinking-water*

Acute exposure of humans to high concentrations of benzene primarily affects the central nervous system. At lower concentrations, benzene is toxic to the haematopoietic system, causing a continuum of haematological changes, including leukaemia. Because benzene is carcinogenic to humans, IARC has classified it in Group 1. Haematological abnormalities similar to those observed in humans have been observed in experimental animal species exposed to benzene. In animal studies, benzene was shown to be carcinogenic following both inhalation and ingestion. It induced several types of tumours in both rats and mice in a 2-year carcinogenesis bioassay by gavage in corn