

tion of the mechanism by which arsenic causes cancer, which appears to be the most sensitive toxicity end-point.

The practical quantification limit for arsenic is in the region of 1–10 µg/l, and removal of arsenic to concentrations below 10 µg/l is difficult in many circumstances. In view of the practical difficulties in removing arsenic from drinking-water, particularly from small supplies, and the practical quantification limit for arsenic, the guideline value of 10 µg/l is retained as a goal and designated as provisional.

The provisional guideline value of 10 µg/l was previously supported by a JECFA PTWI of 15 µg/kg body weight, assuming an allocation of 20% to drinking-water. However, JECFA recently re-evaluated arsenic and concluded that the existing PTWI was very close to the lower confidence limit on the benchmark dose for a 0.5% response (BMDL_{0.5}) calculated from epidemiological studies and was therefore no longer appropriate. The PTWI was therefore withdrawn. Nevertheless, given that, in many countries, even the provisional guideline value may not be attainable, it is retained on the basis of treatment performance and analytical achievability with the proviso that every effort should be made to keep concentrations as low as reasonably possible.

Practical considerations

A silver diethyldithiocarbamate spectrophotometric method (ISO 6595:1982) is available for the determination of arsenic; the detection limit is about 1 µg/l. Graphite furnace AAS, hydride generation AAS and ICP-MS are more sensitive. HPLC in combination with ICP-MS can also be used to determine various arsenic species.

It is technically feasible to achieve arsenic concentrations of 5 µg/l or lower using any of several possible treatment methods. However, this requires careful process optimization and control, and a more reasonable expectation is that 10 µg/l should be achievable by conventional treatment (e.g. coagulation). For local non-piped water supplies, the first option is often substitution by, or dilution with, microbially safe low-arsenic sources. It may also be appropriate to use alternative sources for drinking and cooking but to use the contaminated sources for purposes such as washing and laundry. There are also an increasing number of effective small-scale treatment techniques, usually based around coagulation and precipitation or adsorption, available at relatively low cost for removal of arsenic from small supplies.

For further guidance on identifying and managing arsenic contamination of drinking-water, see *Arsenic primer* ([Annex 1](#)).

Asbestos

Asbestos is introduced into water by the dissolution of asbestos-containing minerals and ores, as well as from industrial effluents and atmospheric pollution. However, the main source of asbestos in drinking-water is asbestos–cement pipes in the distribution system. Rainwater harvesting can contribute to exposure where water runoff is collected from asbestos–cement roofing that is inadequately sealed. Exfoliation of asbestos fibres from asbestos–cement pipes is related to the aggressiveness of the water supply, although, where pipes are already degraded, actions to control water

corrosivity will not prevent asbestos fibre release from the pipes. Exposure to airborne asbestos released from tap water during showers or humidification is unlikely to be significant for human health.

Reason for not establishing a guideline value	No consistent evidence that ingested asbestos is hazardous to health. Further, epidemiological studies have a number of limitations that would preclude their use for deriving a guideline value.
Occurrence	Concentrations in drinking-water are typically less than 1 million fibres per litre (MFL) and rarely exceed 10 MFL. However, much higher concentrations have been reported in drinking-water supplies where asbestos–cement piping is used, although occurrence data are limited.
Limit of detection	Less than 0.1 MFL in water by transmission electron microscopy
Treatment performance	Conventional treatment, including coagulation and filtration, can effectively remove asbestos fibres (>99%) if operation is optimized.
Additional comments	Where existing asbestos–cement pipes are still in active use, suppliers should map and record their location, assess their condition (including related to water aggressiveness) and determine the most appropriate risk reduction strategies.
	Degradation of asbestos–cement materials in drinking-water supplies should be minimized. As these materials fail or deteriorate significantly, the asbestos–cement materials should be replaced with non-asbestos-containing materials. No new sources of asbestos fibres in drinking-water should be introduced.
	Investigative monitoring of asbestos–cement pipes should be considered to provide additional information on the contribution of older asbestos–cement pipes to numbers, types, sizes and shape of fibres in drinking-water.
Assessment date	2021
Principal reference	WHO (2021) <i>Asbestos in drinking-water</i>

Although asbestos is a known human carcinogen by the inhalation route, findings from epidemiological studies that evaluated the correlation between asbestos exposure via drinking-water and incidence of cancers of the stomach and gastrointestinal tract have been inconsistent, with some studies suggesting a weak positive correlation and others finding no evidence of a correlation. However, in extensive studies in experimental animal species, asbestos has not consistently increased the incidence of tumours of the gastrointestinal tract. Thus, the overall weight of evidence from epidemiological and animal studies does not support the hypothesis that oral exposure to asbestos in drinking-water is associated with an increased risk of developing cancer. Further, uncertainties associated with the epidemiological data preclude the establishment of a health-based guideline value for asbestos in drinking-water.

The primary issue surrounding asbestos–cement in drinking-water is for people working on the outside of the pipes (e.g. cutting pipe) or those repairing roof tiles, because of the risk of inhalation of asbestos dust. Where replacement or repair of

pipes is required, it is essential that appropriate measures are taken to prevent any worker exposure to asbestos dust, including during transport and disposal. Similar to asbestos-cement pipes, it is important that appropriate measures are taken to prevent worker and public exposure to asbestos dust generated during work on asbestos-cement roof tiles.

Atrazine and its metabolites

Atrazine is a selective systemic herbicide of the chlorotriazine class, used for the control of annual broadleaf and grassy weeds. Atrazine and its chloro-s-triazine metabolites—deethyl-atrazine, deisopropyl-atrazine and diaminochlorotriazine—have been found in surface water and groundwater as a result of the use of atrazine as a pre-emergent or early post-emergent herbicide. The metabolite hydroxyatrazine is more commonly detected in groundwater than in surface water.

Guideline values	<i>Atrazine and its chloro-s-triazine metabolites:</i> 0.1 mg/l (100 µg/l) <i>Hydroxyatrazine:</i> 0.2 mg/l (200 µg/l)
Occurrence	Concentrations rarely exceed 2 µg/l and are commonly well below 0.1 µg/l
Group ADI for atrazine and its chloro-s-triazine metabolites	0–0.02 mg/kg body weight based on the NOAEL for atrazine of 1.8 mg/kg body weight per day identified on the basis of luteinizing hormone surge suppression and subsequent disruption of the estrous cycle seen at 3.6 mg/kg body weight per day in a 6-month study in rats, using a safety factor of 100
ADI for hydroxyatrazine	0–0.04 mg/kg body weight based on the NOAEL of 1.0 mg/kg body weight per day identified on the basis of kidney toxicity at 7.8 mg/kg body weight per day in a 24-month study in rats, using a safety factor of 25, based on kinetic considerations
Limit of detection	<i>Atrazine:</i> 1 ng/l, isotope dilution MS with solid-phase extraction; 10 ng/l, GC-MS with solid-phase extraction; 50 ng/l, liquid chromatography (LC)–MS with solid-phase extraction; 100 ng/l, GC with nitrogen–phosphorus detection <i>Metabolites:</i> 5 ng/l, capillary GC with nitrogen thermionic specific detection and HPLC with photodiode array absorption detection following extraction with styrene-divinylbenzene sorbents and elution with acetone
Treatment performance	0.1 µg/l can be achieved using GAC or powdered activated carbon (PAC); bankside filtration and nanofiltration are also effective
Guideline value derivation	• allocation to water 20% of upper limit of ADI • body weight 60 kg adult • consumption 2 litres/day
Additional comments	JMPR considered that the NOAEL for atrazine is protective for the consequences of neuroendocrine and other adverse effects caused by prolonged exposure to atrazine and its chloro-s-triazine metabolites.