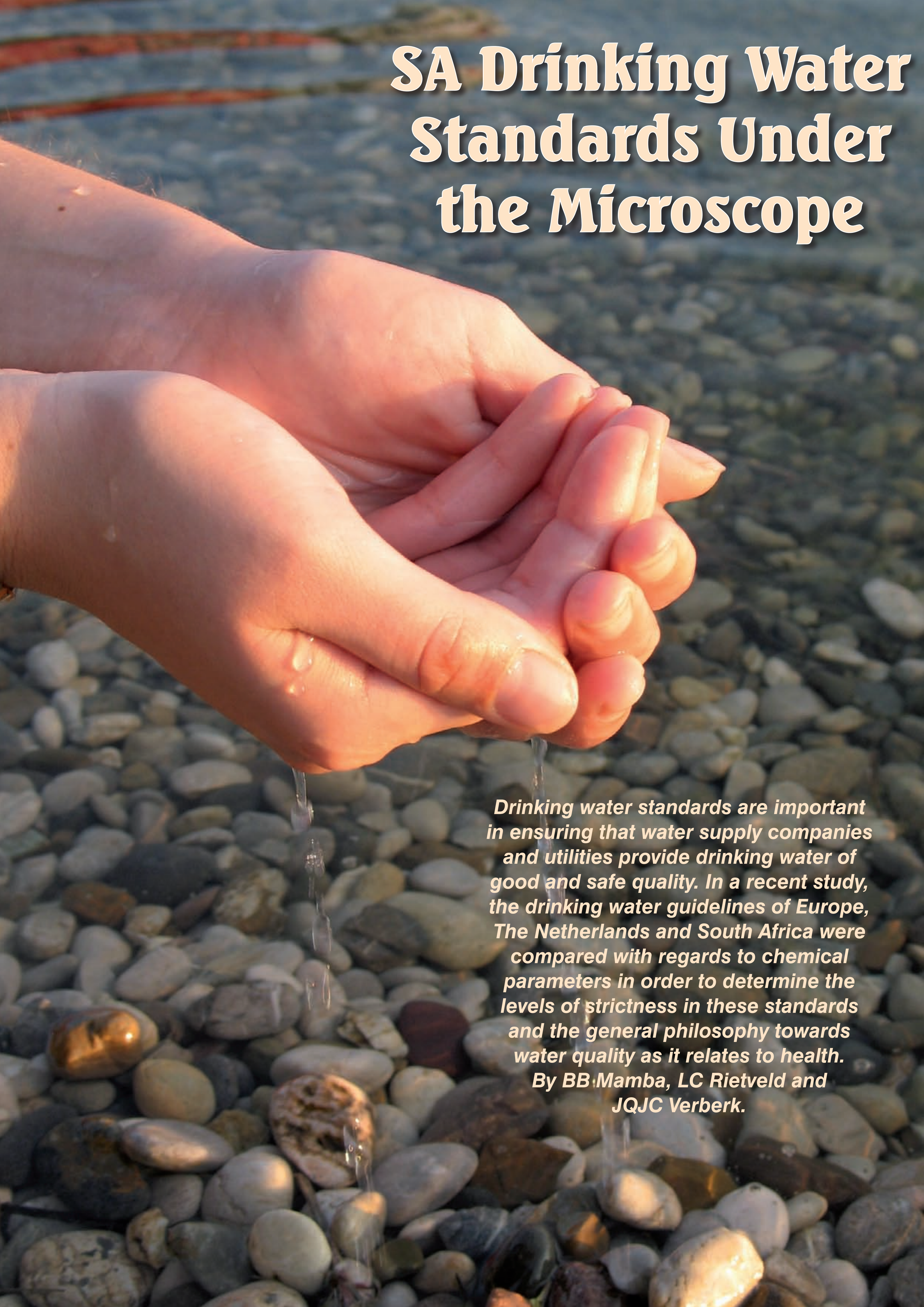

SA Drinking Water Standards Under the Microscope

Drinking water standards are important in ensuring that water supply companies and utilities provide drinking water of good and safe quality. In a recent study, the drinking water guidelines of Europe, The Netherlands and South Africa were compared with regards to chemical parameters in order to determine the levels of strictness in these standards and the general philosophy towards water quality as it relates to health.

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The main aim of treating drinking water is to produce water that is safe (without pathogenic microorganisms and toxic compounds), attractive (free from colour, taste and odour) and to avoid accumulation of solids, corrosion and after-growth of bacteria in the distribution and transport pipeline. Drinking water standards or guidelines should be appropriately set up taking into account national, regional and local situations.

The monitoring and enforcement of these standards differ across the world. In most parts of the world the monitoring is done by water suppliers while the data is audited by public health authorities or regulatory authorities responsible for environmental health. The standards often provide a basis for judging the safety of drinking water in relation to the contaminants of concern. These guidelines also cover contaminants and features that are considered vital in the supply of acceptable and safe drinking water. It is not practical to set standards for every contaminant that could reach drinking water. However, water suppliers should always be up to date about emerging pollutants in water supply lines and then take appropriate action regarding reducing the pollutants' concentration to safe levels or completely remove them.

METHODOLOGY AND RESULTS

The study compared the drinking water standards of South Africa and The Netherlands, which is known for its stringent guidelines. The two countries' drinking water standards were also compared with those of Europe as well as the corresponding guidelines from the World Health Organisation (WHO).

Similarities and differences were noted between the South African National Standard for drinking water, the drinking water standards of The Netherlands and the European Union (EU), as well as the guidelines of the WHO. The comparison was made only on the concentration limits of health-related chemical parameters that are reported in all four of the guidelines (Table 1).

DISCUSSION

The guideline values given in Tables 1 and 2 represent an upper limit of the concentration of individual chemical species that does not exceed tolerable risk to the health of the consumer over a lifetime of consumption. Some chemical contaminants, such as lead and fluoride, may cause ill health effects to water consumers when they are exceeded.

Exceeding the guideline values within a given timeframe that is allowed does not necessarily represent a direct serious risk to health. Some limits in the standards for specific chemical contaminants can be exceeded for limited and specific periods of time without posing any health problems. The length of such a period is also proportional to the individual contaminant concerned particularly when taking into account the level of health risk it poses. Where an analysis points to the fact that the limits have been exceeded then this should signal that an investigation needs to be carried out and appropriate action taken. In this case, possible sources of the toxic substance that has exceeded its limit would have to be identified and remedial action taken with the assistance of public health authorities.

With reference to Table 1, it is not difficult to see why the quality of drinking water and water treatment processes in The Netherlands still rank among the best in the world. When comparing the limits that are allowed for a particular chemical substance, one realises that The Netherlands is much stricter than the general EU standard, let alone the South African drinking water standard. For the past decade, The Netherlands has focused on

TABLE 1
HEALTH RELATED CHEMICAL PARAMETERS (INORGANIC)

Determinand	Unit	WHO max limit	EU max limit	NL max limit	SA max limit
Aluminium	µg/ℓ	200	200	200	300
Ammonia	µg/ℓ	No guideline	500	200	1000
Antimony	µg/ℓ	5	5	5	10
Arsenic	µg/ℓ	10	10	10	10
Bromate	µg/ℓ	Not mentioned	10	1*	Not mentioned
Chromium	µg/ℓ	50	50	50	100
Copper	mg/ℓ	2	2	2	1
Iron	µg/ℓ	300	200	200	200
Lead	µg/ℓ	10	10	10	20
Manganese	µg/ℓ	500	50	50	100
Mercury	µg/ℓ	1	1	1	1
Nickel	µg/ℓ	20	20	20	150
Sodium	mg/ℓ	200	200	150	200
Zinc	mg/ℓ	3	Not mentioned	3	5
Chloride	mg/ℓ	250	250	150	200
Cyanide	µg/ℓ	70	50	50	50
Fluoride	mg/ℓ	1.5	1.5	1.1	1
Sulphate	mg/ℓ	500	250	150	400
Selenium	µg/ℓ	10	10	10	20
Nitrate	mg/ℓ	50 (as total N)	50	50	10 (as total N)
Nitrite	mg/ℓ	50 (as total N)	0.5	0.1	10 (as total N)

** With disinfection a maximum of 5 µg/ℓ is allowed (as 90 percentile value with a maximum of 10 µg/ℓ)*

TABLE 2 HEALTH RELATED CHEMICAL PARAMETERS (ORGANIC)				
Determinand	**Unit**	**NL max limit**	**EU max limit**	**SA max limit**
Polycyclic Aromatic hydrocarbons (PAHs) (sum)	µg/ℓ	0.10	0.1	Not mentioned
Trihalomethanes (sum)	µg/ℓ	25	110	200
Polychlorinated biphenyls (PCBs) (individual)	µg/ℓ	0.10	Not mentioned	Not mentioned
PCBs (sum)	µg/ℓ	0.50	Not mentioned	Not mentioned
Pesticides (individual)	µg/ℓ	0.10	0.1	Not mentioned
Pesticides (sum)	µg/ℓ	0.50	0.5	Not mentioned
Tetra- and tri-chloroethene (sum)	µg/ℓ	10	20	Not mentioned
Vinyl chloride	µg/ℓ	0.50	0.5	Not mentioned
Dissolved organic carbon (DOC) Total organic carbon (TOC)	mg/ℓ	*	*	10

** No abnormal changes*

drinking water research with a primary focus on improving water quality and the robustness of the total water system, including its distribution efficiency.

With reference to the Dutch drinking water industry benchmark, it can be concluded that Dutch water, in general, complies with the legal standards for water quality as prescribed in the Dutch Water Act. The challenge for The Netherlands in the future is to maintain and guarantee water quality of a high standard rather than making an effort to attain such standards. The good quality of drinking water in The Netherlands is evidenced by the fact that its people consume the lowest average number of bottled water in the world.

It is proposed that the practice in The Netherlands which makes it mandatory for water companies to report on an annual basis their compliance and non-compliance to the set maximum limits in the drinking water standard be adopted by countries whose water companies aspire for excellent water quality. Non-compliance in the initial phase of implementation should not necessarily result in punitive action, but should provide an opportunity for corrective measures to be taken so that the quality of the drinking water is not compromised.

South Africa's drinking water standard has generally higher limits compared to those of the EU and The Netherlands. In the drinking water standard document of South Africa, the upper limits are further extended for the individual chemical parameters within specific timeframes of a week, three months, six months, a year, seven years and even ten years for some chemical species. This category is referred to as Class II (maximum allowable for limited duration). The Netherlands and EU standards do not make any allowance for similar classes as found in South African drinking water standard, which implies a higher level of control.

The duration of Class II limits are set depending on the determinand and its potential toxicity. A more toxic substance would probably be given a shorter period of time while the cause for exceeding the limits is still being determined and corrected. The time period is normally considered sufficient for the correction of the 'over-shooting'. The danger of this leeway, however, is that it could be overly extended if not carefully monitored. To effectively assess the limits during the leeway periods would inevitably demand the reinforcement of human resource and capacity. Noteworthy is that the EU and Dutch standards do not judiciously make allowances for the concentration levels of the determinand to be exceeded. The Netherlands, for example, only allows a yearly average of sodium concentration up to a maximum of 150 mg/ℓ, which happens to be the operational maximum limit of the EU and South African standards.

One major factor that influences the concentration of metal ions in the water system is the velocity of water as it runs through the pipelines. In one scenario the velocity may have dropped due to many factors such as a leak which could cause a drop in the velocity resulting in the metal ions settling within the pipes. As soon as the velocity increases, deposits that have been settled can be resuspended which causes a sudden increase in the levels of these species to the detriment of the health of consumers. The Netherlands has over the years changed the pipe material from cast iron and lead to polyvinyl chloride which has not only provided durability but also eliminated metal ions produced after water stagnation.

When considering lead, manganese and chromium, the South African drinking water standard provides for a limit of concentration that is twice that of the EU and The Netherlands, and further allows excesses of up to 50 µg/ℓ, 1 000 µg/ℓ and 500 µg/ℓ respectively for water consumption of up to maximum allowable periods of three months, seven years, and three months, in that order. All the above compounds pose health risks to human life and they need to be carefully monitored. It is suggested that there should be a higher level of strictness for ions of chromium which attain higher concentration levels caused by discharge from steel and erosion of natural deposits.

The concentration limit of nickel allowed in South African drinking water is astoundingly high, at least seven times that allowed by the EU, Dutch and WHO guidelines. Due to the high level of mining operations in South Africa it is expected that levels of nickel could be high. However, such high levels of concentration inevitably call for practical means for the reduction of nickel in drinking water. Reducing the concentration to be within the WHO allowable limits would be the first major step.

Table 2 shows determinands that are organic chemical compounds which can be found in drinking water. The WHO limits are not included here since these guidelines list the individual organic compounds without classifying them. Since the number of organic compounds in water is very large it becomes difficult to measure each one individually. Thus, in many drinking water standards for organic chemicals, the concentration limits are determined on the basis of some properties or groups of compounds. For example, there are a number of organic compounds which fall under the category of pesticides; hence the norm is to group such compounds together. Drinking water standards of the EU and The Netherlands reflect such classification while the South African standard merely refers to the WHO guidelines.

Organic compounds have now become a threat to human health. Although they are often present in very low concentrations in drinking water, they can still have serious health implications. Compounds such as polyaromatic hydrocarbons (PAHs) are generally unreactive to be removed from water through a chemical reaction with a ligand though they can be removed by advanced filtration technologies. Unfortunately, these organic pollutants are toxic even at low concentration levels of parts-per-million (ppm). Most technologies fail to remove these organic micropollutants to acceptable levels. Some of these organic contaminants cannot even be adsorbed on to the activated carbon or trapped by membranes during drinking water treatment, especially at very low concentration levels.

South African natural water systems have higher concentrations of natural organic matter (NOM) even beyond 10 ppm. Organic matter by itself is not toxic, but causes odour and taste problems in the water. During ozonation treatment, organic matter is oxidised leading to the formation of biodegradable dissolved organic carbon (DOC). Ozonation of water produces some undesirable compounds, such as the formation of aldehydes. This is significant since aldehydes can potentially cause adverse health effects. Formaldehyde and acetaldehyde, which are relatively volatile, can result in the formation of respiratory tumours. The problem with high levels of NOM is that toxic oxidation products are often produced during ozonation in the form of peroxide radicals.

It is worth noting that the EU and The Netherlands have set stringent upper limits for organic compounds, including those that may not result from ozonation treatment. One noticeable practice in The Netherlands is the discontinuation of chlorine as disinfectant, which often results in the chlorination of organic matter – the resultant byproducts are often more toxic than the organic matter. In The Netherlands some water utilities use slow sand filtration after the conventional surface water treatment protocol, which includes coagulation, flocculation, sedimentation, softening, filtration, membrane and activated carbon filtration. Other utilities use ultraviolet disinfection in combination with hydrogen peroxide for disinfection and activated carbon for the removal of organic micropollutants. The slow sand filtration treatment improves the physical, chemical and microbiological quality of the water. The slow sand filtration treatment reduces the levels of assimilable organic carbon, which implies less biological growth. Some parts of Europe still disinfect using chlorine; however, Europe's levels of NOM are generally lower than that of South Africa.

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South Africa still predominantly uses chlorine as a disinfectant. Chlorination of organic matter often leads to the formation of trihalomethanes (THMs) and other undesirable byproducts. The US Environmental Protection Agency has reported that THMs have the potential to cause liver, kidney or central nervous system problems and possibly increase the risk of cancer. In Table 2, the South African standard allows almost twice the concentration in THMs compared to the limit set by the EU and almost ten times in relation to the maximum limit set by The Netherlands.

Some pesticides which are found in drinking water are considered to be carcinogenic. Within the group of pesticides there is no differentiation with respect to the different toxicities of the pesticides. In addition, standards are often set for technical or aesthetic reasons for compounds which may not be necessarily toxic, but can influence the taste, colour and odour of water. Still, the use of pesticides in drinking water as larvicides is recommended, though the levels of such compounds in water systems should be carefully monitored. The South African drinking water standard makes no mention of pesticides despite widespread use of insecticides, particularly in the agricultural sector.

One major shortcoming of the South African drinking water standard is its lack of detailed coverage of parameters of organic chemicals. With so much organic matter in South Africa's water systems stricter guidelines should be in place.

CONCLUSION

When comparing the limits of all the chemical parameters in drinking water it is evident that The Netherlands has the strictest and a more detailed standard. This strictness also extends to the Dutch water companies which have to report water quality data on an annual basis so that their compliance and non-compliance to the set limits are monitored, enabling corrective measures when needed.

The Dutch drinking water sector is not driven by adherence to standards given its strict benchmarks, but rather by the aspiration to improve its water treatment process, the removal of bacteria and pollutants in water, and the improvement of the distribution system. The distribution system in The Netherlands has a 2% leakage rate which reduces possibilities of recontamination by infiltration of contaminants and bacterial re-growth. Given such a low leakage level compared to the average leakage rate of 20% in Europe, The Netherlands has a very low pressure drop, further reducing the probability of recontamination.

The EU drinking water standard, though not as strict as that of The Netherlands, on the whole falls within the guidelines of the WHO. The South African drinking water standard was found to be least strict compared to the other standards studied. Furthermore, the South African standard gives allowances to exceed the operational maximum limits within a given time period. It is recommended that the organic chemical determinands be included in the South African standard and that the limits be set for the individual groups of these moieties.