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# SANS 241-1:2015

Edition 2

# SOUTH AFRICAN NATIONAL STANDARD

## Drinking water

## Part 1: Microbiological, physical, aesthetic and chemical determinands

**WARNING**
**This document references other documents normatively.**

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**SANS 241-1:2015**
Edition 2

**Table of changes**

| Change No. | Date | Scope |
|---|---|---|
| | | |

## Foreword

This South African standard was approved by National Committee SABS/TC 147, *Water*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in March 2015.

This document supersedes SANS 241-1:2011 (edition1).

**This document is referenced in the Water Services Act, 1997 (Act No. 108 of 1997): Regulations relating to the compulsory national standards and measures to conserve water, as published by Government Notice No. 509 (Government Gazette No. 22355) of 8 June 2001, the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972), the National Health Act, 2003 (Act No. 61 of 2003), the Constitution of RSA, 1996 (Act No. 108 of 1996), and the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).**

Reference is made in 3.1.13.1 to the "relevant national legislation". In South Africa this means the Local Government: Municipal Structures Act (Act No. 117 of 1998) and the Water Services Act (Act No. 108 of 1997), respectively.

The World Health Organization *Guidelines for drinking-water quality* was used as a guide in deriving the numerical limits given. In the event of changes to specific determinand limits by the WHO, these changes may be implemented in SANS 241 on approval by TC 147.

SANS 241 consists of the following parts, under the general title *Drinking water*:

*Part 1: Microbiological, physical, aesthetic and chemical determinands*.

*Part 2: Application of SANS 241-1*.

Annex A is for information only.

# Contents

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# Drinking water

## Part 1:
Microbiological, physical, aesthetic and chemical determinands

## 1 Scope

**1.1** This part of SANS 241 specifies the quality of acceptable drinking water, defined in terms of microbiological, physical, aesthetic and chemical determinands.

**1.2** Water that complies with this part of SANS 241 is deemed to present an acceptable health risk for lifetime consumption (this implies an average consumption of 2 L of water per day for 70 years by a person that weighs 60 kg).

**1.3** Water services institutions or water services intermediaries (or both) should ensure that water provided by them complies with the numerical limits given in this part of SANS 241.

**1.4** Water services institutions or water services intermediaries (or both) should monitor and maintain monitoring programmes informed by the routine water quality monitoring programme and risk assessment processes described in SANS 241-2.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

SANS 241-2, *Drinking water – Part 2: Application of SANS 241-1*.

World Health Organization (WHO), *Guidelines for drinking-water quality*, Fourth edition, Volume 1, 2011.[1)]

1) http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html

# 3 Definitions and abbreviations

For the purposes of this document, the following definitions and abbreviations apply.

## 3.1 Definitions

**3.1.1**
**determinand**
micro-organism, physical or aesthetic property or chemical substance of which the risk posed is classified under the following four categories:

**3.1.1.1**
**acute health**
determinand that poses an immediate unacceptable health risk if present at concentration values exceeding the numerical limits specified in this part of SANS 241

**3.1.1.2**
**aesthetic**
determinand that taints water with respect to taste, odour or colour and that does not pose an unacceptable health risk if present at concentration values exceeding the numerical limits specified in this part of SANS 241

**3.1.1.3**
**chronic health**
determinand that poses an unacceptable health risk if ingested over an extended period if present at concentration values exceeding the numerical limits specified in this part of SANS 241

**3.1.1.4**
**operational**
determinand that is essential for assessing the efficient operation of treatment systems and risks to infrastructure

**3.1.2**
**disinfectant residual**
disinfectant that remains in solution after disinfection

NOTE 1 In the case of chlorination the residual is in the form of free chlorine and in the case of chloramination the residuals are in the form of free chlorine and monochloramine.

NOTE 2 Disinfection residuals offer partial protection against low level microbiological contamination in a treated water supply.

**3.1.3**
**drinking water**
water that is intended for human consumption

**3.1.4**
***E. coli***
***Escherichia coli***
faecal (thermotolerant) coliform bacteria that ferment lactose or mannitol with the production of both acid and gas, that produce indole from tryptophan, and that hydrolyse 4-methylumbelliferyl-b-D-glucuronide (MUG), all at 44 °C

NOTE 1 The normal habitat of *E. coli* is the large intestine of man and animals, and it is usually not able to multiply in aquatic environments. The presence of *E. coli* in water does, therefore, indicate recent faecal pollution.

NOTE 2 See SANS 9308 (parts 1 and 2).

 

**3.1.5**
**faecal coliforms**
faecal (thermotolerant) coliform bacteria
coliform bacteria that can grow and that have the same fermentative and biochemical properties at 44 °C as they have at 37 °C

NOTE See SANS 9308 (parts 1 and 2).

**3.1.6**
**heterotrophic plate count**
count of the total number of visible colonies produced by micro-organisms in a water sample that grow on agar containing a complex organic carbon source under conditions of incubation specified for various purposes

**3.1.7**
**indicator**
determinand or value derived from determinands that provide information about subject matter with a significance extending beyond that directly associated with a determinand value

**3.1.8**
**protozoan parasite**
unicellular eukaryotic animal that infects specific hosts including humans as part of its life cycle

NOTE For the purposes of this part of SANS 241 the term refers to the *Cryptosporidium* and *Giardia* species.

**3.1.9**
**responsible entity**
water services institutions, water services intermediaries or any person wishing to provide water that is deemed to present an acceptable health risk as defined by this part of SANS 241

**3.1.10**
**somatic coliphage**
bacterial virus that is capable of infecting selected *E. coli* and related host strains by attachment to the bacterial cell wall as the first step of the infection process

NOTE 1 Somatic coliphages produce visible plaques (clearance zones) in a confluent lawn of host bacteria grown under appropriate culture conditions.

NOTE 2 See SANS 10705-2.

**3.1.11**
**total coliforms**
group of aerobic and facultatively anaerobic Gram-negative, non-spore-forming oxidase-negative bacteria that ferment lactose by β-galactosidase activity and that typically inhabit the large intestine of man and animals

NOTE 1 Generally, apart from *E. coli*, many of these bacteria are able to survive and multiply in a natural environment.

NOTE 2 See SANS 9308 (parts 1 and 2).

**3.1.12**
**water services institution**
water services authority or water services provider (or both)

**3.1.12.1**
**water services authority**
any municipality that has the executive authority to provide water services within its area of jurisdiction in terms of the relevant national legislation (see foreword) or the ministerial authorizations made in terms of the relevant national legislation (see foreword)

**3.1.12.2**
**water services provider**
one or more of the following:

a) any person who has a contract with a water services authority or another water services provider to sell water to that authority or provider; or

b) any person who has a contract with a water services authority to assume operational responsibility for providing water services to one or more consumers (end users) within a specific geographic area (retail water services provider); or

c) a water services authority that provides either or both of the services in (a) and (b) itself

**3.1.13**
**water services intermediary**
any person who is obliged to provide water services to another in terms of a contract where the obligation to provide water services is incidental to the main object of that contract

## 3.2 Abbreviations

**NTU** Nephelometric turbidity unit

**Pt-Co** True Colour Unit (Platinum-Cobalt scale)

# 4 Requirements

## 4.1 Suitability and acceptability

The responsible entity that administers this part of SANS 241 shall base its assessment of the suitability and acceptability of water for drinking purposes on the consideration of its microbiological, physical, aesthetic and chemical values as compared to the numerical limits in tables 1 and 2.

## 4.2 Microbiological determinands

**4.2.1** The water shall comply with the numerical limits for the microbiological determinands specified in table 1. Where a microbiological value exceeds the numerical limit given in column 4 of table 1, an unacceptable risk to human health is implied. As the microbiological value increases, an increasing risk to health is implied.

**4.2.2** Disinfection shall be sustained at a level not less than a value defined by the water services institution or water services intermediary (or both) throughout the distribution system such that the water services institution or water services intermediary (or both) ensures that all bacteriological limits listed in table 1, are achieved on a continuous basis.

**4.2.3** In the case of determinands not listed in table 1, the World Health Organization (WHO) *Guidelines for drinking-water quality* shall be used for comparative purposes.

**Table 1 — Microbiological determinands**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Determinand** | **Risk** | **Unit** | **Standard limits** |
| *E. coli* [a] or faecal coliforms [b] | Acute health | Count per 100 mL | Not detected |
| Protozoan parasites [c]<br>*Cryptosporidium* species<br>*Giardia* species | <br>Acute health [g]<br>Acute health [g] | <br>Count per 10 L<br>Count per 10 L | <br>Not detected<br>Not detected |
| Total coliforms [d] | Operational | Count per 100 mL | ≤ 10 |
| Heterotrophic plate count [e] | Operational | Count per mL | ≤ 1 000 |
| Somatic coliphages [f] | Operational | Count per 10 mL | Not detected |

[a] Definitive, preferred indicator of faecal pollution.

[b] Indicator of unacceptable microbial water quality, could be tested instead of *E. coli*, but is not the preferred indicator of faecal pollution. Also provides information on treatment efficiency and aftergrowth in distribution networks.

[c] Confirms a risk of infection and faecal pollution, and also provides information on treatment efficiency. The detection of selected protozoan parasites confirms a human health risk.

[d] Provides information on treatment efficiency and aftergrowth.

[e] Process indicator that provides information on treatment efficiency, aftergrowth in distribution networks and adequacy of disinfectant residuals.

[f] Process indicator that provides information on treatment efficiency.

[g] Determinand that is presently not easily quantifiable and lacks information pertaining to viability and human infectivity, which, however, does pose immediate unacceptable health risks if present in drinking water.

## 4.3 Physical, aesthetic, operational and chemical determinands

**4.3.1** The water shall comply with the physical, aesthetic and chemical numerical limits for lifetime consumption specified in table 2.

**Table 2 — Physical, aesthetic, operational and chemical determinands**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Determinand** | **Risk** | **Unit** | **Standard limits** |
| **Physical and aesthetic determinands** | | | |
| Colour | Aesthetic | mg/L Pt-Co | ≤ 15 |
| Conductivity at 25 °C | Aesthetic | mS/m | ≤ 170 |
| Total dissolved solids | Aesthetic | mg/L | ≤ 1 200 |
| Turbidity | Operational [a] | NTU | ≤ 1 |
| | Aesthetic | NTU | ≤ 5 |
| pH at 25 °C [b] | Operational | pH units | ≥ 5 to ≤ 9,7 |
| **Chemical determinands — macro-determinands** | | | |
| Free chlorine as $Cl_2$ [d] | Chronic health | mg/L | ≤ 5 |
| Monochloramine [cd] | Chronic health | mg/L | ≤ 3 |
| Nitrate as N [ef] | Acute health | mg/L | ≤ 11 |
| Nitrite as N [efg] | Acute health | mg/L | ≤ 0,9 |
| Combined nitrate plus nitrite [etg] | Acute health | | ≤1 |
| Sulfate as $SO_4^{2-}$ | Acute health | mg/L | ≤ 500 |
| | Aesthetic | mg/L | ≤ 250 |
| Fluoride as $F^-$ | Chronic health | mg/L | ≤ 1,5 |
| Ammonia as N | Aesthetic | mg/L | ≤ 1,5 |
| Chloride as $Cl^-$ | Aesthetic | mg/L | ≤ 300 |
| Sodium as Na | Aesthetic | mg/L | ≤ 200 |
| Zinc as Zn | Aesthetic | mg/L | ≤ 5 |
| **Chemical determinands — micro-determinands** | | | |
| Antimony as Sb | Chronic health | µg/L | ≤ 20 |
| Arsenic as As | Chronic health | µg/L | ≤ 10 |
| Barium as Ba | Chronic health | µg/L | ≤ 700 |
| Boron as B | Chronic health | µg/L | ≤ 2 400 |
| Cadmium as Cd | Chronic health | µg/L | ≤ 3 |
| Total chromium as Cr | Chronic health | µg/L | ≤ 50 |
| Copper as Cu | Chronic health | µg/L | ≤ 2 000 |
| Cyanide (recoverable) as $CN^-$ | Acute health | µg/L | ≤ 200 |
| Iron as Fe | Chronic health | µg/L | ≤ 2 000 |
| | Aesthetic | µg/L | ≤ 300 |
| Lead as Pb | Chronic health | µg/L | ≤ 10 |
| Manganese as Mn | Chronic health | µg/L | ≤ 400 |
| | Aesthetic | µg/L | ≤ 100 |
| Mercury as Hg | Chronic health | µg/L | ≤ 6 |

**Table 2** *(concluded)*

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Determinand** | **Risk** | **Unit** | **Standard limits** |
| Nickel as Ni | Chronic health | µg/L | ≤ 70 |
| Selenium Se | Chronic health | µg/L | ≤ 40 |
| Uranium as U | Chronic health | µg/L | ≤ 30 |
| Aluminium as Al | Operational | µg/L | ≤ 300 |
| **Chemical determinands — organic determinands** | | | |
| Total organic carbon as C | Chronic health | mg/L | ≤ 10 |
| Trihalomethanes [h] | | | |
| Chloroform | Chronic health | µg/L | ≤ 300 |
| Bromoform | Chronic health | µg/L | ≤ 100 |
| Dibromochloromethane | Chronic health | µg/L | ≤ 100 |
| Bromodichloromethane | Chronic health | µg/L | ≤ 60 |
| Combined trihalomethane [h] | Chronic health | | ≤ 1 |
| Total microcystin [j] | Chronic health | µg/L | ≤ 1 |
| Phenols | Aesthetic | µg/L | ≤ 10 |

[a] Values in excess of those given in column 4 may negatively impact disinfection.

[b] Low pH values can result in structural problems in the distribution system.

[c] This is equivalent to 4,1 mg Cl as $Cl_2$/L as measured by standard DPD colorimetric and ferrous titrimetric methods.

[d] See 4.2.2.

[e] This is equivalent to nitrate at 50 mg $NO_3^-$/L and nitrite at 3 mg $NO_2^-$/L.

[f] See annex C of SANS 241-2:2014 for an example of the sum of Nitrate plus Nitrite ratio. The sum of the ratios of the concentrations of each (as detected in the sample) to its guideline value should not exceed 1.

[g] Due to the dynamic nature of nitrite-nitrate conversion in distribution networks and the potential health impact on bottle-fed infants, the standard is applicable at the point of consumption.

[h] See annex C of SANS 241-2:2014 for an example of the sum of THM ratio. The sum of the ratios of the concentrations of each to its respective guideline value should not exceed 1.

[j] Microcystin only needs to be measured where an algal bloom (> 20 000 cyanobacteria cells per millilitre) is present in a raw water source. In the absence of algal monitoring, an algal bloom is deemed to occur where the surface water is visibly green in the vicinity of the abstraction, or samples taken have a strong musty odour.

**4.3.2** The health concerns associated with most chemical determinands in drinking water differ from those associated with microbial contamination and arise primarily from the ability of chemical determinands to cause adverse health effects after prolonged periods of exposure.

**4.3.3** The appearance, taste and odour of drinking water should be acceptable to the majority of consumers and the provision of wholesome water should be a high priority. A consumer complaints register shall be kept of all consumer complaints.

**4.3.4** The standard (see column 4 of table 2) represents a numerical limit for each listed determinand that, if met, will safeguard the health of the consumer over a lifetime of consumption. Standards for some chemical determinands (for example lead and nitrate) are set to be protective for susceptible subpopulations. These standards are also protective of the general population over a lifetime of consumption.

**4.3.5** There are few chemical determinands of water that can lead to health problems resulting from a single exposure, except through massive accidental contamination of a drinking water supply. Moreover, experience shows that in many, but not all such incidents, the water becomes undrinkable owing to unacceptable taste, odour and appearance. Only a few chemicals, when present in excessive concentrations, have been shown to cause widespread adverse health effects in humans as a consequence of exposure through drinking water. These chemicals include fluoride, arsenic and nitrite.

Human health effects have also been demonstrated in some areas associated with lead (from domestic plumbing), while there is also concern for the potential extent of exposure to selenium and uranium in some areas at values of human health significance. Iron and manganese are of widespread significance because of their effects on acceptability.

**4.3.6** In the case of determinands not listed in table 2, the World Health Organization (WHO) *Guidelines for drinking-water quality* shall be used for comparative purposes.

**4.3.7** Drinking water treatment chemicals can contribute to the risks present in treated waters. If the values of determinands such as acrylamide monomers exceed the numerical limits specified in the World Health Organization (WHO) *Guidelines for drinking-water quality*, then further investigation and testing should be undertaken to mitigate the risk.

**4.3.8** If the risk assessment indicates potential radioactivity, further testing for gross alpha and beta radioactivity shall be undertaken. If the values exceed the numerical limits specified in the World Health Organization (WHO) *Guidelines for drinking-water quality*, then a full radionuclide analysis shall be undertaken.

## 4.4 Analysis

**4.4.1** Use any method of analysis, the performance of which with regard to trueness, precision and limit of quantification, can offer the necessary level of performance in order to comply with the requirements of this part of SANS 241. In the case of microbiological determinands, methods should be validated against best practice. Results that are measured as less than the limit of quantification shall be reported at a value equal to the limit of quantification preceded by the "<" symbol (for example < 1,0 mg/L).

NOTE See annex A for recommended test methods.

**4.4.2** When the determinand is a metal, ensure that the sample is not filtered but acidified to pH < 2 to determine the acid soluble metals present.

**4.4.3** As technology advances, more cost-effective methods are becoming available and may be used, provided that they offer the required performance. To save costs, the possibility of using simpler methods and microbiological indicator "test kit" methods to calculate operational compliance can be considered (see bibliography).

# Annex A
(informative)

## Recommended test methods

The test methods listed in table A.1 are available for use and are recommended for use in the testing of drinking water. The user should, however, ensure that the analytical method chosen provides the required performance.

**Table A.1 — Test methods**

| 1 | 2 | |
|---|---|---|
| **Determinand** | **Test method** | |
| | **SANS, ASTM, ISO** | **APHA-AWWA-WEF** [a] |
| Aluminium | SANS 381, SANS 6169, SANS 11885 | 3500–Al Aluminium |
| Ammonia | SANS 5217 | 4500–$NH_3$ Nitrogen (Ammonia) |
| Antimony | SANS 379 | 3500–Sb Antimony |
| Arsenic | SANS 376, SANS 11885 | 3500–As Arsenic |
| Bacteriological quality | SANS 5221 | |
| Barium | ASTM D4382 | |
| Boron | SANS 6053 | |
| Cadmium | SANS 5201, SANS 11885 | 3500–Cd Cadmium |
| Chloride | SANS 163-1, SANS 374 | 4500–$Cl^-$ Chloride |
| Chromium | SANS 6054, SANS 11885 | 3500–Cr Chromium |
| Colour | SANS 7887 | 2120 Colour |
| Copper | SANS 5203, SANS 11885 | 3500–Cu Copper |
| Cyanide | SANS 4374, SANS 6703-1, SANS 6703-2 | 4500–$CN^-$ Cyanide |
| Dissolved solids | SANS 5213 | |
| Electrical conductivity | SANS 7888 | |
| Fluoride | SANS 163-1, SANS 10359-1, SANS 10359-2 | 4500–$F^-$ Fluoride |
| Iron | SANS 382, SANS 5207, SANS 11885 | 3500–Fe Iron |
| Lead | SANS 384, SANS 5208, SANS 11885 | 3500–Pb Lead |
| Manganese | SANS 5209, SANS 11885 | 3500–Mn Manganese |
| Mercury | SANS 6059 | 3500–Hg Mercury |
| Nickel | SANS 6171, SANS 11885 | 3500–Ni Nickel |
| Nitrate and nitrite | SANS 5210 | 4500–$N0_3^-$ Nitrogen (Nitrate)<br>4500–$N0_2^-$ Nitrogen (Nitrite) |
| Odour | | 2150 Odor |
| pH | SANS 5011 | 4500–$H^+$ pH value |
| Phenol | SANS 6439 | |
| Selenium | SANS 377, SANS 11885 | 3500–Se Selenium |
| Sodium | SANS 6050, SANS 11885 | 3500–Na Sodium |
| Sulfate | SANS 163-1, SANS 6310 | 4500–$S0_4^{2-}$ Sulfate |
| Taste | | 2160 Taste |
| Total organic carbon | ASTM D4129, ASTM D7573 | |
| Turbidity | SANS 375, SANS 5197 | 2130 Turbidity |
| Uranium | ISO 13166 | |
| Viruses | ISO/TS 15216-1, ISO/TS 15216-2 | |
| Zinc | SANS 383, SANS 5214, SANS 11885 | 3500–Zn Zinc |

[a] *Standard methods on the examination of water and wastewater* (see bibliography).

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ASTM D4382, *Standard test method for barium in water, atomic absorption, spectrophotometry, graphite furnace*.

ASTM D7573, *Standard test method for total carbon and organic carbon in water by high temperature catalytic combustion and infrared detection*.

ISO 6107 (all parts), *Water quality – Vocabulary*.

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ISO 24512, *Activities relating to drinking water and wastewater services – Guidelines for the water management of drinking water utilities and for the assessment of drinking water services*.

ISO/TS 15216-1, *Microbiology of food and animal feed – Horizontal method for determination of hepatitis A virus and norovirus in food using real-time RT-PCR – Part 1: Method for quantification*.

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SANS 379, *Standard test method for antimony in water*.

SANS 381, *Standard test method for aluminium in water*.

SANS 382, *Standard test methods for iron in water*.

SANS 383, *Standard test methods for zinc in water*.

SANS 384, *Standard test methods for lead in water*.

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SANS 5667-11/ISO 5667-11, *Water quality – Sampling – Part 11: Guidance on sampling of groundwaters*.

SANS 6050, *Water – Sodium content*.

SANS 6053, *Water – Boron content*.

SANS 6054, *Water – Chromium content*.

SANS 6059, *Water – Mercury content*.

SANS 6169, *Water – Aluminium content*.

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SANS 6310, *Sulfate content of water (turbidimetric method)*.

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SANS 6703-2/ISO 6703-2, *Water quality – Determination of cyanide – Part 2: Determination of easily liberatable cyanide*.

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# SANS 241-2:2015

Edition 2

# SOUTH AFRICAN NATIONAL STANDARD

## Drinking water

## Part 2: Application of SANS 241-1

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**This document references other documents normatively.**

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**SANS 241-2:2015**
Edition 2

**Table of changes**

| Change No. | Date | Scope |
|---|---|---|
| | | |

## Foreword

This South African standard was approved by National Committee SABS/TC 147, *Water*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in March 2015.

This document supersedes SANS 241:2011 (edition 1).

**This document is referenced in the Water Services Act, 1997 (Act No. 108 of 1997), Regulations relating to the compulsory national standards and measures to conserve water, as published by Government Notice No. 509 (Government Gazette No. 22355) of 8 June 2001, the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972), the National Health Act, 2003 (Act No. 61 of 2003), the Constitution of RSA, 1996 (Act No. 108 of 1996), and the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).**

Reference is made in clause 8 to the "relevant national body". In South Africa this means the South African Water Research Commission.

SANS 241 consists of the following parts, under the general title *Drinking water*:

*Part 1: Microbiological, physical, aesthetic and chemical determinands*.

*Part 2: Application of SANS 241-1*.

Annexes A, B and C are for information only.

# Contents

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# Drinking water

# Part 2:
Application of SANS 241-1

## 1 Scope

**1.1** This part of SANS 241 deals with the evaluation of water quality risks, monitoring and verification of water quality to enable the management of the identified water quality risks. It is not intended to provide a comprehensive water management plan, which is required for the implementation of a water safety plan that deals with related issues such as water quantity, finance and maintenance.

**1.2** This part of SANS 241 is applicable to all water services institutions or water services intermediaries (or both). Assessment of the fitness for use of drinking water against the determinands and numerical limits specified in SANS 241-1 provides the minimum assurance necessary that the water is deemed to present an acceptable health risk for lifetime consumption.

**1.3** It provides the key elements for implementing management actions to comply with SANS 241-1, which include the following:

a) **water quality risk assessment** – assessment of risk from raw water through the treatment works to the point of delivery;

b) **water quality monitoring** – establishment and implementation of operational and compliance water quality monitoring programmes, including the location of sampling points, sampling frequency and determinands;

c) **response monitoring** – incident management and monitoring of drinking water quality when the numerical limits specified in SANS 241-1 are exceeded;

d) **verification of water quality** – calculation of compliance with the numerical limits in SANS 241-1; and

e) **a water safety plan** – a comprehensive water quality management system based on the principles of preventive risk management and incorporating the outcomes in (a) to (d) above.

**1.4** The provision of water deemed to have an acceptable health risk as defined by SANS 241-1 remains the ultimate responsibility of the water services institution or water services intermediary (or both). Water services institutions or water services intermediaries (or both) shall use a risk-based management approach to ensure that safe drinking water is produced at all times and that public health is protected.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

SANS 241-1:2015, *Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinands*.

World Health Organization (WHO), *Guidelines for drinking-water quality*, Fourth edition, Volume 1, 2011.[1)]

## 3 Definitions

For the purposes of this document, the definitions and abbreviations given in SANS 241-1 and the following apply.

**3.1**
**acceptable drinking water**
water deemed to have an acceptable health risk as defined by SANS 241-1 is considered to be safe for lifetime consumption implying an average consumption of 2 L of water per day for 70 years by a person that weighs 60 kg

**3.2**
**contracted bulk customer**
water services authority that receives water in bulk from a water services provider

**3.3**
**critical control point**
step at which control can be applied and that is essential to prevent, eliminate or reduce a water safety hazard (biological, chemical, aesthetic or physical) to an acceptable level

**3.4**
**critical distribution sample point**
critical sampling point that provides information on spatial and temporal risks within the distribution system and that should include locations where the greatest water quality deterioration is anticipated

NOTE Critical distribution sample points are a subset of the distribution sample points and are used for the analysis of the risk defined monitoring programme as well as the annual full SANS 241 analysis.

**3.5**
**distribution sample point**
sample point identified within the network where the water quality within the distribution system zone is monitored for the prescribed process risk indicators

**3.6**
**distribution system**
geographically defined area within which water intended for human consumption may come from one or more sources

**3.7**
**distribution zone**
area within a distribution system that could have a different water quality from other defined zones owing to geographical location, age of infrastructure, distance from the supply source, supplementation from other water sources or a combination of these

NOTE Specific area supplied from a borehole, treatment system, reservoir or tower.

1) http://www.who.int/water_sanitation_health/dwq/guidelines/en/index.html

 

**3.8**
**enteric virus**
virus that infects cells of the gastrointestinal tract as primary site of replication and that is typically transmitted by the faecal-oral route

**3.9**
**final water**
water that emanates from a treatment process (including groundwater, after disinfection)

**3.10**
**hazard**
biological, chemical, physical or radiological determinand that can cause harm to public health or that affects the aesthetic quality of water significantly

**3.11**
**monitoring programme**
ongoing monitoring programme intended to validate the effectiveness of control measures at critical control points and to assess the quality of water based on the location of routine sampling points, sampling frequency and determinands

**3.12**
**point of delivery**
physical fixed interface between a water services provider or a water services authority (or both) and a customer

**3.13**
**prescribed process risk indicator**
mandatory indicator that provides information on the risk posed to treatment efficiency, aftergrowth in distribution networks and adequacy of disinfectant residuals

**3.14**
**prescribed water quality monitoring programme**
mandatory minimum monitoring programme that includes all prescribed determinands at the prescribed frequency

NOTE See tables 1 and 2.

**3.15**
**raw water**
untreated water abstracted from dams, rivers and groundwater

NOTE In the case of reclamation plants, raw water is the effluent from a waste water treatment plant and in the case of a desalination plant, raw water is sea water.

**3.16**
**risk**
likelihood and consequence of the presence of an identified hazard in the distribution system at values that exceed the numerical limits specified in SANS 241-1

**3.17**
**risk defined water quality monitoring programme**
system specific monitoring programme that includes additional determinands identified through the risk assessment at the frequency determined by the associated risk

NOTE See table 3.

**3.18**
**sampling point**
identifiable sampling point within the monitoring programme where a representative sample is collected to determine water quality

NOTE In a water safety plan, sampling points are typically located at critical control points to monitor the efficiency of individual process units in a multiple barrier treatment system.

**3.19**
**sampling frequency**
time interval between consecutive sampling events at a specific sampling point or the number of samples taken over a given period

**3.20**
**verification of water quality**
assessment of compliance with the numerical limits specified in SANS 241-1

**3.21**
**water quality risk assessment**
process of identifying and documenting all hazards and quantification of risks within the distribution system

**3.22**
**water safety plan**
systematic process that aims to consistently ensure acceptable drinking water quality that does not exceed the numerical limits in SANS 241-1 by implementing an integrated water quality management plan, which includes a risk assessment and risk management approach from catchment to point of delivery

**3.23**
**water treatment system**
process or combination of processes undertaken to render raw water acceptable for drinking as defined in SANS 241-1 that includes conventional treatment plants, disinfection of groundwater or any other process used for treating water to an acceptable drinking water quality

# 4 Water quality risk assessment

## 4.1 General

The purpose of this type of risk assessment is to assess risks that might be encountered throughout the supply chain, including raw water, treatment systems, bulk distribution, and distribution zones up to the point of delivery. Emanating from the risk assessment and depending on the nature of the risks identified, adequate monitoring of the identified risks and also the necessary corrective and verification measures shall be put in place.

## 4.2 Requirements for water quality risk assessments

**4.2.1** For the purposes of this type of assessment it is accepted that if a water services institution or water services intermediary (or both) is able to comply with the drinking water quality numerical limits specified in SANS 241-1 on a sustained basis, it will provide water that is deemed acceptable for lifetime consumption.

A risk assessment entails the identification and quantification of all potential hazards and risks within the distribution system.

**4.2.2** Risks are quantified by assessing the value of each determinand over the period of review against the numerical limit specified in SANS 241-1. It should be noted that during a risk assessment it is necessary to analyse for all the water quality determinands listed in tables 1 and 2 of SANS 241-1:2015 as well as any additional determinands anticipated to be in the water that are not listed in SANS 241-1.

Consideration should thus be given to catchment land uses and activities that might result in hazards not specified in SANS 241-1.

Hazards are grouped according to the quality of the water, and potential impact on health (see SANS 241-1:2015, tables 1 and 2), namely:

a) determinands with acute impacts such as bacteria, viruses, protozoa and chemicals, which, if present, at certain unacceptable levels can result in an immediate health risk or consequence;

b) determinands with chronic health effects, which, if present, pose a health risk if ingested over an extended period at levels exceeding the numerical limits listed in tables 1 and 2 of SANS 241-1:2015;

c) any other contaminants that are identified as a risk (see 4.3.5 or 4.3.6 of SANS 241-1:2015);

d) determinands that have aesthetic impacts such as colour; and

e) determinands of operational importance such as total coliforms, turbidity, conductivity, pH and disinfectant residuals.

**4.2.3** A water quality risk assessment shall provide information on water quality at the following locations:

a) water abstracted for purification (raw water);

b) water emanating from a treatment plant (final water);

c) representative points of delivery from water services providers;

d) representative points of delivery to consumers; and

e) where the poorest water quality is anticipated to ensure that all spatial risks are identified.

**4.2.4** The risk assessment should be conducted

a) at a frequency that covers periods when the poorest water quality is anticipated, or during peak demand to ensure that all temporal risks are identified (minimum annually), and

b) in the event of the following situations:

    1) occurrence of any change in the raw water supply that might affect the ability of the water services institution or water services intermediary (or both) to comply with SANS 241-1 and this part of SANS 241;

    2) after a failure of any component of the treatment process that might affect the ability of the water services institution or water services intermediary (or both) to comply with SANS 241-1 and this part of SANS 241;

    3) a new treatment system is put into service;

    4) a refurbished treatment system is recommissioned;

    5) a new distribution system is put into service;

    6) a distribution zone is altered or recommissioned; and

    7) a different treatment chemical is used,

    such that full information on all spatial and temporal risks is not available.

**4.2.5** It is recommended that, as part of the risk assessment for enteric viruses, the viral load in source waters be characterized either through the use of actual sampling and testing or by undertaking a sanitary survey and monitoring indicator organisms, taking all spatial and temporal risks into account.

Owing to methodological limitations, available laboratories, cost and turnaround times, viral analysis is impractical for routine monitoring. However, where sampling and analysis cannot be conducted sufficiently, an indication of the risk presented by enteric viruses should be based on a thorough assessment of the levels of human faecal pollution that affect source waters.

**4.2.6** Protozoan parasite monitoring shall be done on raw and final waters to determine the parasite load and to assess the efficacy of the water treatment process.

## 4.3 Interpretation of water quality risk assessments

Results of analyses shall be interpreted as follows and used to adapt monitoring accordingly:

a) If the determinand exceeds the numerical limit specified in SANS 241-1 in both the raw and final water, it implies that the existing treatment system or operation thereof is not removing the determinand. Appropriate treatment systems shall be installed or the operation of the existing system shall be optimized to ensure that the numerical limit for the required water quality determinand is met. The determinand shall be included in the water quality monitoring programme as part of the risk defined monitoring programme (see 5.3.3 (table 3)).

b) If the determinand that exceeds the numerical limit in the raw water is removed to the extent that it complies with SANS 241-1 in the final water, it implies that the installed infrastructure is adequate to deal with the problem. To verify that ongoing optimized operation of infrastructure is sustained, include the determinand in the risk defined monitoring programme (see 5.3.3 (table 3)).

c) If both raw and final water comply with the numerical limits specified in SANS 241-1, risks are deemed within acceptable limits. While maintaining the prescribed monitoring programme (see 5.3.2 (tables 1 and 2)), analyses for the remaining determinands listed in SANS 241-1 shall be performed at a minimum annually as part of the risk assessment (see 4.2.4).

d) Drinking water treatment chemicals can contribute to the risks present in treated waters. Aluminium, iron, disinfectant residuals and ammonia are examples of determinands that can be impacted by operational processes. The treatment process shall be optimized and these determinands shall be included in the prescribed monitoring programme if determinands exceed the limits specified in SANS 241-1 (see 5.3). Determinands, such as trihalomethanes, that may form between the input points to contracted bulk customers and the distribution delivery points to the extent that they exceed the numerical limits given in SANS 241-1, shall be included as part of the risk defined monitoring programme (see 5.3.3 (table 3)).

e) If enteric viruses are detected in source waters or if there is any evidence that source waters are affected by human faecal pollution then evidence of the efficacy of treatment barriers should be obtained.[2)] Demonstration of the effective operation of these barriers within the water treatment system includes the maintenance of data records of determinands for final water as given in table 1.

f) Although monitoring for viruses in the final water is not compulsory, such analysis currently provides the only direct indication of the overall efficacy of a treatment plant to remove viruses and should be included wherever possible.[2)]

2) U.S. EPA's *Disinfection profiling and benchmarking guidance manual* (U.S. EPA, 1999).

# 5 Routine water quality monitoring programmes

## 5.1 General

All water services institutions or water services intermediaries (or both) shall implement a water quality monitoring programme. The monitoring programme comprises the following two activities:

a) a prescribed water quality monitoring programme, which shall be implemented and adhered to as outlined in 5.3.2 and tables 1 and 2; and

b) a risk defined water quality monitoring programme, which shall be implemented for those determinands identified during the risk assessment as outlined in 5.3.3 and table 3.

## 5.2 Sampling points

Sampling points shall be selected in a manner that will ensure that the quality of the water can be verified throughout the entire water supply chain. Sampling points shall, at minimum, include the following as applicable to the distribution system:

a) raw water;

b) final water;

c) representative points of delivery; and

d) representative sampling points within the distribution zone to ensure 80 % coverage of the distribution system area.

NOTE Distribution sampling points within the network could include post-water treatment works, reservoirs, major delivery points, network dead ends, remote network supply points, high occupancy buildings, hospitals schools and other areas identified with elevated risk.

## 5.3 Determinands and frequency of analyses

### 5.3.1 Water quality monitoring programmes

Water quality monitoring programmes shall include the monitoring activities as specified in 5.3.2 to 5.3.5.

### 5.3.2 Prescribed water quality monitoring programme

The analysis of water quality determinands shall comply with table 1, which is the minimum requirement for characterizing raw water quality, ongoing levels of operational efficiency in a water treatment system and acceptable final water quality to the point of delivery. For the distribution system, the provisions in table 2 shall also apply.

Owing to the reduced variability of water quality in groundwater supply systems, monthly analyses shall be deemed adequate, provided that no results were detected at levels exceeding the numerical limits in SANS 241-1 during the risk assessment. In such an event, the requirements of 5.3.3 shall also apply.

**Table 1 — Minimum monitoring for prescribed process risk indicators**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Determinand** | **Minimum monitoring frequency** | | |
| | **Raw water** | **Final water** | **Distribution system** |
| Conductivity or total dissolved solids | Daily | Daily | Not applicable |
| pH value | Daily | Once per shift [a] | Fortnightly |
| Turbidity | Daily | Once per shift [a] | Fortnightly |
| Disinfectant residuals | Not applicable | Once per shift [a] | Fortnightly |
| *E. coli* (or faecal coliforms) [b] | Not applicable | Weekly | Fortnightly (see table 2) |
| Heterotrophic plate count [c] | Not applicable | Weekly | Fortnightly |
| Treatment chemicals [d] | Not applicable | Monthly | Not applicable |

[a] A shift is defined as an eight-hour work period.
[b] If non-compliant with the numerical limits specified in SANS 241-1, implement corrective action and immediate follow-up sampling at an increased sampling frequency.
[c] If non-compliant with the numerical limits specified in SANS 241-1, implement corrective action and follow-up sampling.
[d] Includes all risk defined determinands that are added or formed as a result of the use of treatment chemicals (for example aluminium, iron and chlorine). If non-compliant with the numerical limits specified in SANS 241-1 in the final water, the distribution system monitoring frequencies of table 3 apply.

The monitoring frequency for *E. coli* (or faecal coliforms) within the distribution system shall at minimum be in accordance with the requirements set out in table 2, provided that the water services institution or water services intermediary (or both) is able to provide an appropriate guarantee that the water complies with the numerical limits specified in SANS 241-1.

**Table 2 — Minimum sample numbers for *E. coli* (or faecal coliforms) in distribution systems**

| 1 | 2 |
|---|---|
| **Population served** | **Total number of samples per month** [a] Minimum |
| < 5 000 | 2 |
| 5 000 to 100 000 | 1 per 5 000 head of population + 1 additional sample [b] |
| 100 000 to 500 000 | 1 per 10 000 head of population + 11 additional samples [b] |
| ≥ 500 000 | 1 per 20 000 head of population + 36 additional samples [b] |

[a] During the rainy season, sampling should be carried out more frequently to ensure that all spatial and temporal risks are identified.
[b] See WHO, *Guidelines for drinking-water quality*.

### 5.3.3 Risk defined monitoring programme

**5.3.3.1** Risk defined monitoring programmes require additional monitoring of all determinands identified in the risk assessment (see 4.3) that might result in non-compliance with the numerical limits specified in SANS 241-1. To verify that ongoing optimized operations of water treatment and distribution systems are sustained, determinands exceeding the numerical limits specified in SANS 241-1 shall be monitored in the following manner

a) raw water non-compliance – risk defined monitoring on raw and final waters,

b) final water non-compliance – risk defined monitoring on raw, final and critical distribution system sampling points, and

c) distribution water non-compliance – risk defined monitoring on the critical distribution system sampling points

at the minimum frequencies indicated in table 3.

**Table 3 — Frequency of analyses for determinands identified during the risk assessment exceeding the numerical limits in SANS 241-1**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Risk** | **Frequency** | | |
| | **Raw water** | **Final water** | **Critical distribution system points** |
| Acute health bacteriological risk determinands | See table 1 | See table 1 | See table 2 |
| Protozoan parasite risk determinands | Not applicable | Monthly | Not applicable |
| Acute health chemical risk determinands | Weekly | Weekly | Monthly |
| Chronic health risk determinands | Monthly | Monthly | Monthly |
| Aesthetic risk determinands | Monthly | Monthly | Quarterly |
| Operational risk determinands [a] | Weekly | Weekly | Monthly |
| [a] Aluminium should be monitored on the final water in accordance with table 1 and monthly on the distribution system. | | | |

**5.3.3.2** The monitoring frequencies given in table 3 also apply to determinands that deteriorate between the points of delivery (input points to contracted bulk customers and the distribution delivery points to customers) to the extent that the determinands exceed the numerical limits specified in SANS 241-1.

**5.3.3.3** Monitoring for all determinands included in the risk informed monitoring programme shall continue until such time that the water services institution or water services intermediary (or both) can substantiate that the identified determinand no longer constitutes an unacceptable risk.

### 5.3.4 Monitoring of desalination systems

Final drinking water from desalination plants shall comply with the numerical limits specified in SANS 241-1. In applying SANS 241-1 account shall, however, be taken of significant differences between desalination systems and systems that abstract water from freshwater sources. The risk assessment shall account for these differences and changes shall be made accordingly to the water quality monitoring programmes as described in 5.3.2 and 5.3.3.

### 5.3.5 Monitoring of reclamation systems

Final drinking water from reclamation distribution systems shall comply with the numerical limits specified in SANS 241-1. In applying SANS 241-1 to reclamation distribution systems, account shall be taken of the relatively high risk of microbiological contamination. Apart from an increased requirement for testing for *E. coli*/faecal coliforms, the monitoring programme shall also include more resistant microbiological determinands such as protozoan parasites at frequencies recommended in tables 1 to 3 to verify that the drinking water complies with the requirements in SANS 241-1. Indicators not listed in SANS 241-1, shall comply with the values stated in the World Health Organization (WHO) *Guidelines for drinking-water quality*.

# 6 Response monitoring

## 6.1 Incident management of drinking water quality failures

When a result from a drinking water sample exceeds the numerical limits in tables 1 or 2 of SANS 241-1:2015, further investigation and corrective action are required. The adverse risk to consumers increases with an increased deviation of the result from the numerical limits listed in SANS 241-1. The nature and urgency of the corrective actions required shall be guided by the impact of the non-compliant determinand(s).

## 6.2 Microbiological determinands

Remedial action and non-routine follow-up sampling are required for any acute health determinand that exceeds the numerical limits specified in table 1 of SANS 241-1:2015. A resolution to the problem shall be implemented in the shortest time. The increased sampling frequency shall continue until such time as results are compliant. The water safety plan shall include or refer to an incident management protocol for the management of drinking water quality failures.

## 6.3 Chemical, physical, aesthetic and operational determinands

Remedial action and non-routine follow-up sampling are required for any acute or chronic health chemical determinand that exceeds the numerical limits specified in table 2 of SANS 241-1:2015.

While non-compliance with the physical, operational and aesthetic numerical limits does not necessarily imply that the water is unacceptable for consumption, it does indicate potential shortcomings that require resampling and implementation of corrective action in the treatment and distribution processes.

# 7 Verification of water quality

## 7.1 General

Verification of the fitness for use of drinking water against the determinands and numerical limits specified in SANS 241-1 provides the minimum assurance necessary that the water is deemed to present an acceptable health risk for lifetime consumption. For optimal management of water quality and determination of water quality compliance in accordance with SANS 241, it is important to differentiate between the risk defined compliance and drinking water quality compliance.

The risk defined compliance shall include the prescribed process risk indicators as given in 5.3.2 as well as all determinands identified as a risk in the risk assessment as given in clause 4 and 5.3.3. The drinking water quality compliance calculation shall include all determinands listed in tables 1 and 2 of SANS 241-1:2015. Any determinand identified as a risk, which is not listed in tables 1 and 2 of SANS 241-1:2015 shall be included in the risk defined compliance where the numerical limits in the WHO, *Guidelines for drinking-water quality*, shall be used to calculate compliance.

NOTE See annexes A, B and C for examples of verification calculations.

## 7.2 Calculation of risk defined compliance

The risk defined compliance shall be calculated using equation 1 by including all determinands listed in the prescribed water quality monitoring programme (as given in 5.3.2) as well as all determinands identified as a risk in the risk assessment (as given in clause 4) and using all data measured in both the prescribed water quality monitoring programme and the risk defined monitoring programme (as given in 5.3.3) on final and distribution waters as part of the water safety planning process.

The risk defined compliance of each prescribed or risk defined determinand, shall be calculated individually (see 5.3 and tables 1 and 3). The risk defined compliance of each determinand shall be compared to and classified in accordance with each determinands risk category (see table 4).

The risk defined compliance is calculated using equation 1:

$$\text{Risk defined compliance (per determinand)} = \frac{\text{number of compliant determinand results}}{\text{total number of determinand results}} \times 100\ \% \qquad (1)$$

Examples of these calculations are given in tables A.1 and A.2.

NOTE Nitrite and the sum of nitrate-plus-nitrite compliance ratio are included in this calculation only for water at the point of consumption.

## 7.3 Calculation of drinking water quality compliance

### 7.3.1 General

The drinking water quality compliance shall be calculated at least annually against all the determinands monitored on the final and distribution waters. This calculation shall include all data from the risk assessment as given in clause 4 (risk assessment process) and as given in clause 5 (water quality monitoring). Equations 2 to 6 are required for calculation of drinking water quality compliance with SANS 241-1.

### 7.3.2 Drinking water compliance

The five compliance calculations shall be determined as follows:

a) The **acute health microbiological compliance** is calculated using equation 2:

$$\text{Acute health microbiological compliance} = \frac{\text{number of compliant microbiological results}}{\text{total number of microbiological results}} \times 100\ \% \qquad (2)$$

NOTE This calculation will include data from all microbiological analyses including *E. coli*, faecal coliforms, and protozoan parasites.

b) The **acute health chemical compliance** is calculated using equation 3:

$$\text{Acute health chemical compliance} = \frac{\text{number of compliant acute health chemical results}}{\text{total number of acute health chemical results}} \times 100\ \% \qquad (3)$$

NOTE Nitrite and the sum of nitrate-plus-nitrite compliance ratio are included in this calculation only for water at the point of consumption.

c) The **chronic health chemical compliance** is calculated using equation 4:

$$\text{Chronic health chemical compliance} = \frac{\text{number of compliant chronic health chemical results}}{\text{total number of chronic health chemical results}} \times 100\ \% \quad (4)$$

d) The **operational compliance** is calculated using equation 5:

$$\text{Operational compliance} = \frac{\text{number of compliant operational results}}{\text{total number of operational results}} \times 100\ \% \quad (5)$$

e) The **aesthetic compliance** is calculated using equation 6 as follows:

$$\text{Aesthetic compliance} = \frac{\text{number of compliant aesthetic results}}{\text{total number of aesthetic results}} \times 100\ \% \quad (6)$$

### 7.4 Performance categorization of distribution systems

The performance of distribution systems for risk defined compliance as well as for drinking water quality compliance shall be categorized according to the percentage of samples complying and the population served as given in table 4.

## 8 Requirements for water safety plans

It is the current international view that the use of a comprehensive risk assessment and also a risk management approach, which includes all steps of the supply chain from catchment to the point of delivery, is the most effective means of consistently ensuring the safety of drinking water supplies.

Water services institutions or water services intermediaries (or both) shall therefore establish, implement and maintain water safety plans. Guidance on such plans is available from the World Health Organization and the relevant national body (see foreword). Water safety plans are integrated water quality management plans that embrace the hazard assessment and critical control point (HACCP) and multiple-barrier principles and shall, when established, implemented and maintained, ensure treated drinking water of a quality that complies with the requirements in SANS 241-1.

NOTE Water services institutions or water services intermediaries (or both) should "move away from the mindset of monitoring to verify the quality of water with the assumption that the water is safe, toward one of monitoring to detect contamination most effectively with the knowledge that contamination potential is always present. This requires information that will increase the understanding of the entire water supply chain and provide improved insight on hazards, risks, treatment performance and overall vulnerability of the water supply chain" (see *Strategic water quality monitoring for drinking water safety*).

**Table 4 — Categorization of distribution systems based on performance**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| **Performance indicator** | **Quality of the distribution system** | **Proportion of compliant results** % | |
| | | **Population size** | |
| | | **Up to 100 000** | **> 100 000** |
| **Risk defined compliance (Equation 1)** | | | |
| **Acute health microbiological risk determinand** | Excellent | ≥ 97 | ≥ 99 |
| | Good | ≥ 95 | ≥ 97 |
| | Unacceptable | < 95 | < 97 |
| **Acute health chemical risk determinand** | Excellent | ≥ 97 | ≥ 99 |
| | Good | ≥ 95 | ≥ 97 |
| | Unacceptable | < 95 | < 97 |
| **Chronic health chemical risk determinands** | Excellent | ≥ 95 | ≥ 97 |
| | Good | ≥ 93 | ≥ 95 |
| | Unacceptable | < 93 | < 95 |
| **Operational risk determinands** | Excellent | ≥ 93 | ≥ 95 |
| | Good | ≥ 90 | ≥ 93 |
| | Unacceptable | < 90 | < 93 |
| **Aesthetic risk determinands** | Excellent | ≥ 93 | ≥ 95 |
| | Good | ≥ 90 | ≥ 93 |
| | Unacceptable | < 90 | < 93 |
| **Drinking water quality compliance** | | | |
| **Acute health microbiological compliance (equation 2)** | Excellent | ≥ 97 | ≥ 99 |
| | Good | ≥ 95 | ≥ 97 |
| | Unacceptable | < 95 | < 97 |
| **Acute health chemical compliance (equation 3)** | Excellent | ≥ 97 | ≥ 99 |
| | Good | ≥ 95 | ≥ 97 |
| | Unacceptable | < 95 | < 97 |
| **Chronic health chemical compliance (equation 4)** | Excellent | ≥ 95 | ≥ 97 |
| | Good | ≥ 93 | ≥ 95 |
| | Unacceptable | < 93 | < 95 |
| **Operational compliance (equation 5)** | Excellent | ≥ 93 | ≥ 95 |
| | Good | ≥ 90 | ≥ 93 |
| | Unacceptable | < 90 | < 93 |
| **Aesthetic compliance (equation 6)** | Excellent | ≥ 93 | ≥ 95 |
| | Good | ≥ 90 | ≥ 93 |
| | Unacceptable | < 90 | < 93 |

# Annex A
(informative)

## Example of risk and compliance calculations for a large municipality serving more than 100 000 people

The water for this municipality is supplied from a eutrophic impoundment serving 1 200 000 people. The water treatment works is sophisticated and uses an aluminium chlorohydrate polymer blend to flocculate and remove particulate matter before being disinfected with chlorine gas. The water is pumped to the distribution system where it is fed into 60 reservoirs supplying the community.

There are 96 sampling points in the distribution network, consisting of 60 at the reservoir sites plus 36 others at representative sites, including clinics, schools and municipal offices. Of these 96 sampling points, 16 critical sampling points have been identified. These critical sampling points are used to monitor risk determinands in the network and are used for full SANS 241 analysis list sampling within the distribution.

Hazards identified during the risk assessment are iron (aesthetic risk), turbidity (operational and prescribed risk), colour, protozoan parasites, algal toxins (total microcystin), total organic carbon and trihalomethanes. Iron and turbidity are not risks at the chronic limits and are monitored in accordance with the risks identified, namely iron at the aesthetic risk frequency specified in table 3 and turbidity at the prescribed risk frequency specified in table 1.

According to table 2, at least one sample per 20 000 head of population plus 36 additional samples are required for *E.coli* in the distribution system per month. Therefore the total number of samples in the system for *E. coli* = 1 200 000/20 000 = 60 samples. Sixty samples per month + 36 additional samples = 96 samples per month required for *E.coli* in the distribution system. These samples are taken at the 96 sampling points in the distribution and are taken to comply with the fortnightly requirement of table 1.

A full SANS 241 analysis is required on each of the critical points at least annually, but preferably at a frequency that covers periods when the poorest water quality is anticipated or during peak demand to ensure that all temporal risks are identified. Prescribed and risk defined determinands are monitored at the frequencies determined by tables 1 and 3.

Compliance of each prescribed or risk defined determinand is calculated individually. Drinking water compliance calculations take all the determinands monitored on the final and distribution waters, including the risk assessment process, into consideration when calculating compliance.

In this example, no resamples (i.e. samples in addition to failed samples) have been included in the calculations to assist with understanding the methodology of calculating compliance.

**Table A.1 — Prescribed and identified risk defined compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** | **Risk** |
| Conductivity | Final water: daily (1 × 365) Distribution:[a] (16 × 4) | P | 429 | 429 | 100,00 | ≥ 93 | Yes | Aesthetic |
| pH at 25 °C | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | P | 2 247 | 2 247 | 100,00 | ≥ 93 | Yes | Operational |
| Turbidity Operational limit (≤ 1 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | R/P | 2 247 | 2 174 | 96,75 | ≥ 93 | Yes | Operational/ Aesthetic |
| Disinfectant residual (free chlorine) [b] | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | P | 2 247 | 1 874 | 83,40 | ≥ 95 | No | Prescribed |
| *E. coli*/faecal coliforms [c] | Final water: weekly (1 × 52) Distribution: fortnightly (96 × 12) | P | 1 204 | 1 200 | 99,67 | ≥ 99 | Yes | Acute health |
| Heterotrophic plate count | Final water: weekly (1 × 52) Distribution: fortnightly (96 × 12) | P | 1 204 | 1 099 | 91,28 | ≥ 93 | No | Operational |
| Treatment chemicals (aluminium) | Final water: monthly (1 × 12) | P | 12 | 12 | 100,00 | ≥ 93 | Yes | Operational |

**Table A.1** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** | **Risk** |
| Colour | Final water: monthly (1 × 12) Distribution: quarterly (16 × 4) | R | 76 | 70 | 92,11 | ≥ 93 | No | Aesthetic |
| Protozoan parasites | Final water: monthly (1 × 12) | R | 12 | 12 | 100,00 | ≥ 99 | Yes | Acute health |
| Algal toxins (Microcystin) | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 195 | 95,59 | ≥ 97 | No | Chronic health |
| Total organic carbon | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 188 | 92,16 | ≥ 95 | No | Chronic health |
| Iron as Fe Aesthetic limit (≤ 300 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (16 × 4) | R | 76 | 70 | 92,11 | ≥ 95 | No | Aesthetic |
| Chloroform | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 195 | 95,59 | ≥ 95 | Yes | Chronic health |
| Bromoform | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 190 | 93,14 | ≥ 95 | No | Chronic health |
| Dibromochloro-methane | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes | Chronic health |

**Table A.1** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** | **Risk** |
| Bromodichloro-methane | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes | Chronic health |
| Sum of trihalomethane compliance ratio | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes | Chronic health |

[a] Not required but monitored by water services institution or water services intermediary (or both) on a quarterly basis.
[b] Limit set by water services institution or water services intermediary (or both).
[c] This would also include any presence/absence tests although, if positive, a quantitative test should be undertaken and immediate resampling should be undertaken as stipulated in table 1.

**Table A.2 — Overall microbiological compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| *E. coli*/faecal coliforms [a] | Final water: weekly (1 × 52) Distribution: fortnightly (96 × 12) | P | 1 204 | 1 200 | 99,67 | ≥ 99 | Yes |
| Protozoan parasites | Final water: monthly (1 × 12) | R | 12 | 12 | 100,00 | ≥ 99 | Yes |
| Overall microbiological compliance | | | **1 216** | **1 212** | **99,84** | **≥ 99** | **Yes** |

[a] This would also include any presence/absence tests although, if positive, a quantitative test should be undertaken and immediate resampling should be undertaken as stipulated in table 1.

**Table A.3 — Overall acute health chemical compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Nitrate as N | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 97 | Yes |
| Nitrite as N | Final water:[a] quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 64 | 64 | 100,00 | ≥ 97 | Yes |
| Sum of nitrite plus nitrate ratios | Distribution system only: quarterly (16 × 4) | N | 64 | 64 | 100,00 | ≥ 97 | Yes |
| Sulfate as $SO_4^{2-}$ Acute health limit (≤ 500 mg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 97 | Yes |
| Cyanide (recoverable) as $CN^-$ | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 97 | Yes |
| Overall acute health chemical compliance | | | **332** | **332** | **100,00** | **97** | **Yes** |

[a] Not required but monitored by water services institution or water services intermediary (or both) on a quarterly basis.

**Table A.4 — Overall chronic health chemical compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Free chlorine | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Monochloramine | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Fluoride as $F^-$ | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Antimony as Sb | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Arsenic as As | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Barium as Ba | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Boron as B | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |

**Table A.4** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Cadmium as Cd | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Total chromium as Cr | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Copper as Cu | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Iron as Fe Chronic health limit (≤ 2 000 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (16 × 4) | N | 76 | 76 | 100,00 | ≥ 95 | Yes |
| Lead as Pb | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Manganese as Mn Chronic health limit (≤ 400 µg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Total organic carbon | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 188 | 92,16 | ≥ 95 | No |
| Chloroform | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 195 | 95,59 | ≥ 95 | Yes |

**Table A.4** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Bromoform | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 190 | 93,14 | ≥ 95 | No |
| Dibromochloromethane | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes |
| Bromodichloromethane | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes |
| Sum of trihalomethane compliance ratio | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 204 | 100,00 | ≥ 95 | Yes |
| Algal toxins (microcystin) | Final water: monthly (1 × 12) Distribution: monthly (16 × 12) | R | 204 | 195 | 95,59 | ≥ 97 | No |
| Mercury as Hg | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Nickel as Ni | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Selenium as Se | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |

**Table A.4** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Uranium as U | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 95 | Yes |
| Overall chronic health chemical compliance | | | **2 592** | **2 544** | **98,15** | **≥ 95** | **Yes** |

**Table A.5 — Overall operational compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| pH at 25 °C | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | P | 2 247 | 2 247 | 100,00 | ≥ 93 | Yes |
| Turbidity Operational limit (≤ 1 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | P/R | 2 247 | 2 174 | 96,75 | ≥ 93 | Yes |
| Treatment chemicals (aluminium) | Final water: monthly (1 × 12) | P | 12 | 12 | 100,00 | ≥ 93 | Yes |
| Total coliforms | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Heterotrophic plate count | Final water: weekly (1 × 52) Distribution: fortnightly (96 × 12) | P | 1 204 | 1 099 | 91,28 | ≥ 93 | No |
| Somatic coliphages | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Overall operational compliance | | | **5 846** | **5 668** | **96,96** | **≥ 93** | **Yes** |

**Table A.6 — Overall aesthetic compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Colour | Final water: monthly (1 × 12) Distribution: quarterly (16 × 4) | R | 76 | 70 | 92,11 | ≥ 93 | No |
| Conductivity | Final water: daily (1 × 365) Distribution: [a] (16 × 4) | P | 76 | 70 | 92,11 | ≥ 93 | No |
| Total dissolved solids | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Turbidity Aesthetic limit (≤ 5 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (96 × 12) | P/N | 2 247 | 2 247 | 100,00 | ≥ 93 | Yes |
| Sulfate as $SO_4^{2-}$ Aesthetic limit (≤ 250 mg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Ammonia as N | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |

**Table A.6** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Chloride | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Sodium as Na | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Zinc as Zn | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Iron as Fe Aesthetic limit (≤ 300 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (16 × 4) | R | 76 | 70 | 92,11 | ≥ 93 | No |
| Manganese as Mn Aesthetic limit (≤ 100 µg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Phenols | Final water: quarterly (1 × 4) Distribution: quarterly (16 × 4) | N | 68 | 68 | 100,00 | ≥ 93 | Yes |
| Overall aesthetic compliance | | | **3 019** | **3 001** | **99,40** | **93** | **Yes** |

[a] Not required but monitored by water services institution or water services intermediary (or both) on a quarterly basis.

**Table A.7 — Total/overall compliance**

| 1 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|
| **Determinand** | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Microbiological compliance | 1 216 | 1 212 | 99,67 | ≥ 99 | Yes |
| Acute health chemical compliance | 332 | 332 | 100,00 | ≥ 97 | Yes |
| Chronic health chemical compliance | 2 592 | 2 544 | 98,15 | ≥ 95 | Yes |
| Operational compliance | 5 846 | 5 668 | 96,96 | ≥ 93 | Yes |
| Aesthetic compliance | 3 019 | 3 001 | 99,40 | ≥ 93 | Yes |
| Total/overall compliance | **13 005** | **12 757** | **98,84** | | |

# Annex B
(informative)

## Example of risk and compliance calculations for a small municipality serving fewer than 100 000 people

The water for this municipality is supplied from three different boreholes serving 26 400 people. According to table 2, one sample per 5 000 head of population plus one additional sample are required for *E.coli* in the distribution system per month. Therefore the total number of samples in the system for *E.coli* = 26 400/5 000 = 5,28 samples. This is rounded up to six samples per month. Six samples per month plus one additional sample equals seven samples per month required for *E.coli* in the distribution system. These samples are taken at the seven sampling points in the distribution system and are taken to comply with the fortnightly requirements of table 1.

The boreholes are pumped into one large final water reservoir without any additional treatment and are disinfected with chlorine gas. The water is pumped to the distribution system where it is fed into three reservoirs supplying the community, which are also used as distribution sampling points. Distribution sampling points have been identified at four additional sampling sites within the network (hospital, clinic, school and municipal offices). A full set of analyses on all determinands listed in SANS 241 is conducted annually, however, owing to possible seasonal variations, most determinands are monitored on a seasonal basis, i.e. four times per annum. This sampling frequency ensures that all spatial and temporal risks are apparent and will cover periods when the most unacceptable raw water quality is anticipated or during peak demand to determine site-specific water quality risks.

Of the seven sampling points in the distribution network, three critical distribution sampling points have been identified. These critical distribution sampling points are used to monitor risk determinands in the network and are used for the full SANS 241 list analysis.

Risks identified in the risk assessment include

a) colour,

b) chloride,

c) fluoride,

d) nitrate,

e) turbidity,

f) manganese (aesthetic risk), and

g) iron (aesthetic risk).

Owing to the fact that the iron and manganese have been identified as aesthetic risks and not chronic risk determinands, they are monitored at the frequency specified in table 3 for the type of risk identified. Nitrite is usually monitored at the same time as nitrate and therefore in this example, the frequency of the nitrite analysis matches the nitrate analysis, and is also a requirement for the combined nitrate plus nitrite ratio in the network. To ensure clarity and for the purposes of this example, none of the additional samples which would be analysed owing to a failure are included in the calculated example.

Prescribed and risk defined compliance of each prescribed or risk defined determinand is calculated individually. Drinking water compliance calculations take all the determinands monitored on the final and distribution waters, including the risk assessment process into consideration when calculating compliance.

**Table B.1 — Prescribed and identified risk defined compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** | **Risk** |
| Conductivity | Final water: daily (1 × 365) Distribution:[a] (3 × 4) | P | 377 | 377 | 100,00 | ≥ 93 | Yes | Prescribed/ Aesthetic |
| pH at 25 °C | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P | 1 179 | 1 179 | 100,00 | ≥ 93 | Yes | Prescribed/ Operational |
| Turbidity Operational limit (≤ 1 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | R/P | 1 179 | 1 085 | 92,03 | ≥ 93 | No | Operational/ Aesthetic |
| Disinfectant residual (free chlorine) [b] | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P | 1 179 | 1 141 | 96,78 | ≥ 95 | Yes | Prescribed |
| *E. coli*/faecal coliforms [c] | Final water: weekly (1 × 52) Distribution: fortnightly (7 × 12) | P | 136 | 135 | 99,26 | ≥ 99 | Yes | Prescribed/ Acute health |
| Heterotrophic plate count | Final water: weekly (1 × 52) Distribution: fortnightly (7 × 12) | P | 136 | 136 | 100,00 | ≥ 93 | Yes | Prescribed/ Operational |
| Colour | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 22 | 91,67 | ≥ 93 | No | Risk informed/ Aesthetic |

**Table B.1** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** | **Risk** |
| Chloride | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 23 | 95,83 | ≥ 93 | Yes | Risk informed/ Aesthetic |
| Fluoride | Final water: monthly (1 × 12) Distribution: monthly (3 × 12) | R | 48 | 46 | 95,83 | ≥ 95 | Yes | Risk informed/ Chronic health |
| Nitrate as N | Final water: weekly (1 × 52) Distribution: monthly (3 × 12) | R | 88 | 84 | 95,45 | ≥ 97 | No | Risk informed/ Acute health |
| Manganese as Mn Aesthetic limit (≤ 100 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 23 | 95,83 | ≥ 93 | Yes | Risk informed/ Aesthetic/ Chronic health |
| Iron as Fe Aesthetic limit (≤ 300 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 23 | 95,83 | ≥ 93 | Yes | Risk informed/ Aesthetic/ Chronic health |

[a] Not required but monitored by water services institution or water services intermediary (or both) on a quarterly basis.
[b] Limit set by water services institution or water services intermediary (or both).
[c] This would also include any presence/absence tests although, if positive, a quantitative test should be undertaken and immediate resampling should be undertaken as stipulated in table 1.

**Table B.2 — Overall microbiological compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| *E. coli*/faecal coliforms [a] | Final water: weekly (1 × 52) Distribution: fortnightly (7 × 12) | P | 136 | 135 | 99,26 | ≥ 99 | Yes |
| Protozoan parasites | Final water: annually (1 × 1) | N | 1 | 1 | 100,00 | ≥ 99 | Yes |
| Overall microbiological compliance | | | **137** | **136** | **99,27** | **≥ 99** | **Yes** |

[a] This would also include any presence/absence tests although, if positive, a quantitative test should be undertaken and immediate resampling should be undertaken as stipulated in table 1.

**Table B.3 — Overall acute health chemical compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Nitrate as N | Final water: weekly (1 × 52) Distribution: monthly (3 × 12) | R | 88 | 84 | 95,45 | ≥ 97 | No |
| Nitrite as N | Final water: weekly (1 × 52) Distribution: [a] monthly (3 × 12) | N | 88 | 88 | 100,00 | ≥ 97 | Yes |
| Sum of nitrite: nitrate compliance ratio | Distribution system only: monthly (3 × 12) | R | 36 | 36 | 100,00 | ≥ 97 | Yes |
| Sulfate as $SO_4^{2-}$ Acute health limit (≤ 500 mg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 97 | Yes |
| Cyanide (recoverable) as $CN^-$ | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 97 | Yes |
| Overall acute health chemical compliance | | | **244** | **240** | **98,36** | **97** | **Yes** |

[a] Nitrite analysis shall be done monthly on the distribution system to calculate the nitrate:nitrite ratio.

**Table B.4 — Overall chronic health chemical compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Free chlorine | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Monochloramine | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Fluoride | Final water: monthly (1 × 12) Distribution: monthly (3 × 12) | R | 48 | 46 | 95,83 | ≥ 95 | Yes |
| Antimony as Sb | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Arsenic as As | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Barium as Ba | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Boron as B | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |

**Table B.4** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Cadmium as Cd | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Total chromium as Cr | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Copper as Cu | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Iron as Fe Chronic limit (≤ 2 000 µg/L) | Final water: monthly (1 × 12) Distribution: monthly (3 × 4) | N | 24 | 24 | 100,00 | ≥ 93 | Yes |
| Lead as Pb | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Manganese as Mn Chronic limit (≤ 400 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | N | 24 | 24 | 100,00 | ≥ 93 | Yes |
| Total organic carbon as C | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Chloroform | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |

**Table B.4** *(continued)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Bromoform | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Dibromochloromethane | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Bromodichloromethane | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Sum of trihalomethane compliance ratio | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Total microcystin [a] | Not applicable | | | | | | |
| Mercury as Hg | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Nickel as Ni | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Selenium as Se | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |

**Table B.4** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Uranium as U | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 95 | Yes |
| Overall chronic health chemical compliance | | | **416** | **414** | **99,52** | **≥ 95** | **Yes** |

[a] Not applicable owing to the nature of the water source.

**Table B.5 — Overall operational compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| pH at 25 °C | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P | 1 179 | 1 179 | 100,00 | ≥ 93 | Yes |
| Turbidity Operational limit (≤ 1 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P/R | 1 179 | 1 085 | 92,03 | ≥ 93 | No |
| Aluminium as Al | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Disinfectant residual (free chlorine) [a] | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P | 1 179 | 1 141 | 96,78 | ≥ 95 | Yes |
| Total coliforms | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Heterotrophic plate count | Final water: weekly (1 × 52) Distribution: fortnightly (7 × 12) | P | 136 | 136 | 100,00 | ≥ 93 | Yes |
| Somatic coliphages | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Overall operational compliance | | | **3 721** | **3 589** | **96,45** | **≥ 93** | **Yes** |

[a] Limit set by water services institution or water services intermediary (or both).

**Table B.6 — Overall aesthetic compliance**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Colour | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 22 | 91,67 | ≥ 93 | No |
| Conductivity | Final water: daily (1 × 365) Distribution: quarterly (3 × 4) | P/N | 377 | 377 | 100,00 | ≥ 93 | Yes |
| Total dissolved solids | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Turbidity Aesthetic limit (≤ 5 NTU) | Final water: per shift (1 × 3 × 365) Distribution: fortnightly (7 × 12) | P/R | 1 179 | 1 111 | 94,23 | ≥ 93 | Yes |
| Sulfate as $SO_4^{2-}$ Aesthetic limit (≤ 250 mg/L) | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Ammonia as N | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |

**Table B.6** *(concluded)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **Determinand** | **Minimum no. of samples required as in SANS 241 formulation (per annum)** sample no. × frequency | **Risk character** P = prescribed monitoring R = identified risk N = negligible risk | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Chloride | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 24 | 100,00 | ≥ 93 | Yes |
| Sodium as Na | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Zinc as Zn | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Iron as Fe Aesthetic limit (≤ 300 µg/L) | Final water: monthly (1 × 12) Distribution: monthly (3 × 4) | R | 24 | 23 | 95,83 | ≥ 93 | Yes |
| Manganese as Mn Aesthetic limit (≤ 100 µg/L) | Final water: monthly (1 × 12) Distribution: quarterly (3 × 4) | R | 24 | 23 | 95,83 | ≥ 93 | Yes |
| Phenols | Final water: quarterly (1 × 4) Distribution: quarterly (3 × 4) | N | 16 | 16 | 100,00 | ≥ 93 | Yes |
| Overall aesthetic compliance | | | **1 768** | **1 676** | **95,88** | **93** | **Yes** |

**Table B.7 — Total/overall compliance**

| 1 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|
| **Determinand** | **Actual no. of samples (per annum)** | **No. of compliant results (per annum)** | **Compliance achieved** % | **Required compliance** % | **Compliance status** |
| Microbiological compliance | 137 | 136 | 99,27 | ≥ 99 | Yes |
| Acute health chemical compliance | 244 | 240 | 98,36 | ≥ 97 | Yes |
| Chronic health chemical compliance | 416 | 414 | 99,52 | ≥ 95 | Yes |
| Operational compliance | 3 721 | 3 589 | 96,45 | ≥ 93 | Yes |
| Aesthetic compliance | 1 748 | 1 676 | 95,88 | ≥ 93 | Yes |
| Total/overall compliance | **6 266** | **6 055** | **97,90** | | |

# Annex C
(informative)

## Calculation of combined trihalomethane and combined nitrate plus nitrite concentrations

The numbers in tables C.1 and C.2 are given for the purpose of demonstrating the calculations only.

**Table C.1 — Example of calculations for trihalomethane concentrations**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Compound** | **Limit** µg/L | **Value** µg/L | **Value/limit** [a] | **Complies** Yes/no |
| Chloroform | 300 | 180 | 0,60 | Yes |
| Bromoform | 100 | 2 | 0,02 | Yes |
| Dibromochloromethane | 100 | 4 | 0,04 | Yes |
| Bromodichloromethane | 60 | 25 | 0,42 | Yes |
| **Sum of ratios** | | | **1,08** | **No** |
| [a] If THMs are detected at levels below the quantification limit, the quantification limit shall be used in the calculation. | | | | |

**Table C.2 — Example of combined nitrate plus nitrite calculations**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Compound** | **Limit** mg/L | **Value** mg/L | **Value/limit** | **Complies** Yes/no |
| Nitrate [a] as N | 11 | 1,1 | 0,1 | Yes |
| Nitrite [a] as N | 0,9 | 0,45 | 0,5 | Yes |
| **Sum of ratios** | | | **0,6** | **Yes** |
| [a] Nitrite and the sum of nitrate plus nitrite compliance ratio is only applicable at the point of use. | | | | |

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