DRAFT GHANA STANDARD **DGS 175:2021**

Water Quality – Specification for drinking water

1 Scope

This Ghana Standard specifies the requirements, methods of sampling and test for potable water obtained from “prepared waters” or “waters defined by origin”.

The standard also applies to packaged drinking water but not packaged mineral water.

2 Normative references

The following standards contain provisions which have been referred to in this Ghana Standard. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these reference standards.

2.1 **GS 220**, Water Quality – Specification for Mineral Water

2.2 **GS 595,** Plastics – Positive list of constituents of polyethylene in contact with food, pharmaceuticals and drinking water

2.3 **GS 598,** Plastics – List of pigments and colourants for use in plastics in contact with food, pharmaceuticals and drinking water

2.4 **GS 173,** Plastics – Packaging – Standard specification for plastic films made from low-density polyethylene and linear low-density polyethylene for general use and packaging applications

2.5 **GS 1239,** Plastics – Specification for polyethylene terephthalate (PET) preform

2.6 **GS 786**, Recommended code of hygienic practice for the collection, processing and marketing of potable water

2.7 **GS D858**, Standard Test Method for Manganese in Water

2.8 **GS D1126**, Standard Test Method for Hardness in Water

2.9 **GS ISO 5667-1**, Water quality – Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques

2.10 **GS ISO 5667-3**, Water quality – Sampling – Part 3: Guidance on the preservation and handling of water samples.

2.11 **GS ISO 5667-4**, Water quality – Sampling – Part 4: Guidance on sampling from lakes, natural and man-made

2.12 **GS ISO 5667-5**, Water quality -- Sampling -- Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems.

2.13 **GS ISO 6222**, Water quality – Enumeration of cultural micro-organisms – Colony count by inoculation in a nutrient agar culture medium

2.14 **GS ISO 6332**, Water quality - Determination of iron - Spectrometric method using 1,10-phenanthroline

2.15 **GS ISO 6703 – 2**, Water quality - Determination of cyanide - Part 2: Determination of easily liberatable cyanide

2.16 **GS ISO 6777**, Water quality - Determination of nitrite - Molecular absorption spectrometric method

2.17 **GS ISO 7393-1**, Water quality - Determination of free chlorine and total chlorine -- Part 1: Titrimetric method using N, N-diethyl-1,4-phenylenediamine

2.18 **GS ISO 7393-3**, Water quality - Determination of free chlorine and total chlorine -- Part 3: Iodometric titration method for the determination of total chlorine

2.19 **GS ISO 7887**, Water quality – Examination and determination of colour

2.20 **GS ISO 7890-3**, Water quality - Determination of nitrate - Part 3: Spectrometric method using sulfosalicylic acid

2.17 **GS ISO 8199,** Water quality – General guidance for microbiological examination by enumeration of micro-organisms on culture media

2.18 **GS ISO 9297**, Water quality - Determination of chloride - Silver nitrate titration with chromate indicator (Mohr's method)

2.19 **GS ISO 10304 – 1**, Water quality - Determination of dissolved anions by liquid chromatography of ions - Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulphate

2.20 **GS ISO 10359-1**, Water quality - Determination of fluoride - Part 1:Electrochemical probe method for potable and lightly polluted water

2.21 **GS ISO 10359-2,** Water quality - Determination of fluoride – Part 2: Determination of inorganically bound total fluoride after digestion and distillation

2.22 **GS ISO 10523**, Water quality - Determination of pH

2.23 **GS ISO 11704**, Water quality - Measurement of gross alpha and beta activity concentration in non-saline water - Liquid scintillation counting method

2.24 **GS ISO 12020,** Water quality – Determination of aluminium – Atomic absorption spectrometric methods

2.25 **GS ISO 15923-1**, Water quality - Determination of selected parameters by discrete analysis systems - Part 1: Ammonium, nitrate, nitrite, chloride, orthophosphate, sulfate and silicate with photometric detection

2.26 **GS ISO 17378 – 2,** Water quality – Determination of arsenic and antimony - Part 2: Method using hydride generation atomic absorption spectrometry (HG-AAS)

2.27 **GS ISO 19458**, Water quality – Sampling for microbiological analysis

2.28 **GS ISO 5667-6**, Water quality – Sampling – Part 6: Guidance on sampling of rivers and streams

2.29 **GS ISO 7027-1**, Water quality – Determination of turbidity – Part 1:Quantitative methods

2.30 **GS ISO 5667-11**, Water quality – Sampling – Part 11: Guidance on sampling of ground waters

2.31 **GS ISO 9308-1**, Water quality — Enumeration of *Escherichia coli* and coliform bacteria — Part 1: Membrane filtration method for waters with low bacterial background flora

2.32 **GS ISO 11704,** Water Quality - Measurement of Gross Alpha and Beta Activity Concentration in Non - Saline water – Liquid Scintillation Counting Method

2.33 **GS ISO 14189**, Enumeration of *Clostridium perfringens* – Method using Membrane filtration

2.34 **ISO 9390**, Water Quality – Determination of Borate in water – Spectrometric method using azomethine - H

3 Definitions

For the purposes of this standard the following definitions apply:

3.1
apparent colour
colour due to dissolved substances and undissolved suspended matter determined in the original water sample without filtration or centrifugation

3.2
deep well
water well that is 15 m deep or more

3.3
drinking water
water of a quality, suitable and safe for drinking

3.4
groundwater
water, which is held in an aquifer (water bearing formation, be it rock or soil) that can usually be abstracted for use and can be recovered from or via an underground formation

3.5
lot
all packages belonging to one batch of manufacture in any consignment

3.6
packaged water
drinking water (3.2) packaged in hermetically sealed containers. It may contain minerals or carbon dioxide, naturally occurring or intentionally added

3.7
"prepared waters"
water that may originate from any type of water supply

3.8
shallow well
water well that is less than 15 m deep

3.9
"waters defined by origin"
waters that come from underground or from the surface (specific environmental resources) without passing through a water treatment system

4 Description of "waters defined by origin" and "prepared waters"

4.1 'Waters defined by origin'

"Waters defined by origin", whether they come from the underground or from the surface as defined in 3.7 share the following characteristics:

4.1.1 they originate from specific environmental resources without passing through a water treatment system;

4.1.2 precautions have been taken within the vulnerability perimeters to avoid any pollution of, or external influence on, the chemical, microbiological and physical qualities of water at origin;

4.1.3 collecting conditions which guarantee the original microbiological purity and essential elements of their chemical make-up at origin;

4.1.4 from the microbiological standpoint, are constantly fit for human consumption at their source and are kept in that state with particular hygienic precautions until and while packaging in accordance with provisions of 5.7.2 and 6.

4.1.5 are not subject to any modification or treatment other than those permitted under 6.1.

4.2 'Prepared waters'

"Prepared waters" are waters that do not comply with all the provisions set for waters defined by origin' under 4.1. They may originate from any type of water supply.

5 Requirements

5.1 Physical requirements

5.1.1 Turbidity

The turbidity expressed in Nephelometric Turbidity Units (NTU) shall not exceed 5 units when drinking water is tested in accordance with GS ISO 7027-1.

5.1.2 Apparent colour

The apparent colour shall not exceed 5 Hazen Units when determined in accordance with GS ISO 7887.

5.1.3 Odour and taste

The odour and taste shall not be objectionable to most consumers when tested in accordance with the method given in Annex A of this standard.

5.1.4 Temperature

Drinking water shall be at ambient temperature.

5.1.5 Total Suspended Solids/Matter

The Total Suspended Solids/Matter in packaged drinking water expressed in milligrams per litre shall not exceed zero (0 mg/L) when tested in accordance with the method in Annex B.

5.2 Chemical requirements

5.2.1 When tested in accordance with the appropriate method given in Table 1, the water shall conform to the requirements given in Table 1.

NOTE: All the parameters for which the requirements are given in Table 1 can also be evaluated using the test methods given in volume 11.01 and volume 11.02 of the current annual book of ASTM standards or current edition of Standard Methods for the Examination of Water and Wastewater.

Table 1- Chemical requirements

SL No.	Parameter	Requirement	Method of Test
1	Aluminium, (as Al) mg/L, max	0,2	GS ISO 12020
2	Chloride (as Cl), mg/L, max	250	GS ISO 9297
3	Iron (as Fe), mg/L, max	0,3	GS ISO 6332 Annex E
4	pH	6,5 – 8,5*	GS ISO 10523
5	Total dissolved solids, mg/L, max	500	Annex F
6	Sulphate (SO_4), mg/L, max	250	GS ISO 10304-1 GS ISO 15923-1

7	Total hardness, mg/L, max	500	D1126
8	Arsenic (as As), mg/L, max	0,01	GS ISO 17378-2
9	Residual free Chlorine*, mg/L, min	0,2	GS ISO 7393-1 GS ISO 7393-2 GS ISO 7393-3
10	Free Cyanide (as CN), mg/L, max	0,07	GS ISO 6703-2,
11	Fluoride (as F), mg/L, max	1,5	GS ISO 10359-1, GS ISO 10359-2,
12	Nitrite (as NO_2), mg/L, max	3,0	GS ISO 6777,
13	Nitrate (as NO_3), mg/L, max	50,0	GS ISO 7890-3
14	Boron (as B), mg/L, max	1,0	ISO 9390
*For effective disinfection, there should be a residual concentration of free chlorine of ≥ 0,5mg/L after at least 30min contact time at pH < 8,0			

5.2.2 It is recommended that in addition to the requirements given in 5.2.1, assessment of the parameters given in Annex C should be undertaken at least once a year.

5.3 Bacteriological requirements

When drinking water is tested in accordance with the methods given in Table 2, it shall conform to the requirements given in the table.

Table 2 – Bacteriological requirements

No.	Determinants	Requirement	Test Method
1	Total viable count, count/ml, at 37ºC for 48 hr	500	GS ISO 6222
2	Total viable count, count/ml, at 22°C for 72 hr	50	GS ISO 6222
3	*E. coli*, count/100ml	< 1	GS ISO 9308-1
4	Total coliform, count/100 ml	< 1	GS ISO 9308-1
5	*Clostridium perfringens* count/100 ml	< 1	GS ISO 14189
6	*Enterococcus faecalis* count/100 ml	< 1	GS ISO 7899-2
7	*Pseudomonas aeruginosa* count/100 ml	< 1	GS ISO 16266

5.4 Virological quality

All drinking water shall be free of human enteroviruses to ensure negligible risk of infection.

Note:

1 Virological studies have indicated that drinking water treatment can reduce the levels of viruses but may not eliminate them completely from very large volumes of water. Virological, epidemiological and risk analysis have provided some important information, although it is still insufficient for deriving quantitative and direct virological criteria. Such criteria cannot be given for routine use because of the cost, complexity and lengthy nature of virological analysis and the fact that they cannot detect the most relevant viruses.

2 The criteria, which have been given in Table 3, are based upon the degree of treatment necessary to ensure that even very large volumes of drinking water have a negligible risk of containing viruses.

3 Ground water obtained from a protected source and documented to be free from faecal contamination from its zone of influence, the wells, pumps and delivery system can be assumed to be virus-free. However, when such water is distributed, it is desirable that it is disinfected and that a residual level of disinfectant is maintained in the distribution system to guard against contamination.

Table 3 – Recommended treatments for different water sources to produce water with negligible viral risk

Type of source	Recommended treatment
A. Ground water	
Protected, deep well; essentially free of faecal contamination	Disinfection
Unprotected shallow wells, faecally contaminated	Filtration and disinfection
B. Surface water	
Protected, impounded upland water; essentially free of faecal contamination	Disinfection
Unprotected impounded water or upland river; faecal contamination	Filtration and disinfection
Unprotected lowland rivers; faecal contamination	Pre-disinfection or storage, filtration, disinfection
Unprotected watershed; heavy/gross faecal contamination	Not recommended for water supply

5.5 Parasitological quality

Drinking water shall not contain any pathogenic protozoa, helminthes and any other free-living organisms.

Note:

1. The analytical methods for protozoan pathogens are expensive and time consuming and therefore are not recommended for routine use.

2. The control of pathogenic parasites and of other invertebrate animal life in water mains is best accomplished by proper operation and control of water treatment processes and distribution practices. In particular, the attainment of the bacteriological criteria and the application of treatments for virological reduction should, except in extraordinary cases of extreme contamination by parasites, ensure that the water has a negligible risk of transmitting parasitic diseases.

5.6 Radiological requirements

When samples of drinking water are tested in accordance with the method given in Table 4, it shall not exceed the screening values given in Table 4.

Table 4 – Radioactive constitution

Constituent	Requirement	Method of Test
Gross alpha activity, Bq/L, max.	0,1	ISO 11704
Gross beta activity, Bq/L, max.	1,0	ISO 11704

5.7 Additional requirements for packaged waters

5.7.1 General

All packaged water shall not contain sugars, sweeteners, flavourings or other food additives.

5.7.2 Hygiene

5.7.2.1 Code of practice

All waters covered by the provisions of this standard shall be collected, transported, stored, and if applicable, treated and packaged in accordance with GS 786.

5.7.2.2 Approval and inspection of the source for "waters defined by origin**"**

Initial approval or inspection of the source of 'waters defined by origin' shall be based upon appropriate scientific study adapted to the type of resource (hydrogeology, hydrology, etc) and based on field survey of the source and of the recharge zone that shall demonstrate the safety of the source, the facilities and collection operations. The initial inspection of the source shall be confirmed on a regular basis by periodic monitoring of the essential constituents, temperature, flow (in the case of natural springs) and the chemical and radiological factors specified under 5.2 and 5.6 and the microbiological standards established in conformity with this standard. In the case of imported waters, results of source inspection shall be made available to the certification / regulatory body upon request.

6. Modifications and handling of packaged waters

6.1 Permitted physicochemical modifications and antimicrobial treatments for the waters defined by origin

Waters defined by origin shall not, prior to packaging, be modified or subjected to treatments other than those described in 6.1.1 and 6.1.2 with the provision that these modifications or treatments and the processes used to achieve them do not change the essential physicochemical characteristics nor compromise the chemical, radiological and microbiological safety of these waters when packaged.

6.1.1 Selective treatments that modify the original composition:

a) reduction and/or elimination of dissolved gases (and resulting in possible change in pH);

b) addition of carbon dioxide (and resulting in change in pH) or re-incorporation of the original carbon dioxide present at emergence;

c) reduction and/or elimination of unstable constituents such as iron, manganese, sulphur (as S^0 or S^{2-}) compounds and carbonates in excess, under normal conditions of temperature and pressure, of the calcium-carbonate equilibrium;

d) addition of air, oxygen or ozone on condition that the concentration of by-products resulting from the ozone treatment is below the tolerance established under 5.2 and 5.6

e) decrease and/or increase in temperature; and

f) reduction and/or separation of elements originally present in excess of maximum concentrations or of maximum levels of radioactivity in accordance with 5.2 and 5.6

6.1.2 Antimicrobial treatments for 'waters defined by origin'

Antimicrobial treatments shall be used singly or in combination solely in order to conserve the original microbiological fitness for human consumption, original purity and safety of waters defined by origin.

6.2 Physical and chemical modifications and antimicrobial treatments for prepared waters

Prepared waters shall be subjected to any microbial treatments and any treatments that modify the physical and chemical characteristics of the original water on condition that such treatments result in prepared water that comply with all provisions of 5.2, 5.3,5.4,5.5, 5.6, and 5.7.3 regarding the chemical, microbiological and radiological safety requirements for pre-packaged waters.

7 Sampling

7.1 Drinking water other than packaged water

It is not practicable to prescribe a standard frequency of sampling without taking into consideration all the variables associated with a water supply, which include effects on the water from climatic, human and industrial activities, the volume of water processed, the population served, the area of reticulation and the capabilities of the analytical facility (both in terms of capacity and in terms of analytical performance). For this reason, it is necessary to establish a sampling programme that takes into consideration appropriate international recommendations.

7.1.1 The recommendations given in GS ISO 5667-1 shall be used as the basis for the establishment of a sampling programme, and the recommendations given in GS ISO 5667-3, GS ISO 5667-4, GS ISO 5667-5, GS ISO 5667-6, GS ISO 5667-11 and GS ISO 19458 should be used as the basis for implementing the sampling programme.

7.1.2 In the absence of a formally established sampling programme, the suggested minimum sampling frequency given in Table 5 should be used as an interim measure for drinking water in the distribution system.

Table 5 – Minimum sampling frequencies for drinking water in the distribution system

Population served	Samples to be taken monthly
Less than 5000	1 sample
5001 – 100,000	1 sample per 5000 population
More than 100,000	1 sample per 10,000 population plus 10 additional samples

7.2 Packaged drinking water

7.2.1 General requirements

7.2.1.1 Marking

Each sample shall be marked with the necessary details of sampling and the containers for bacteriological testing shall be marked separately.

7.2.1.2 Storage

The units of the sample shall be handled and stored in such a manner that there shall be no deterioration of the quality of the water. (see GS ISO 5667-3)

7.2.1.3 Samples for bacteriological tests

The samples for bacteriological testing shall be brought to the testing laboratory within one hour of sampling. If this is not possible the samples shall be stored at 10ºC or below and transported to the testing laboratory within 24 hours. (see GS ISO 19458**)**

7.2.2 Scale of sampling for packaged water

Samples shall be tested from each lot for ascertaining its conformity to the requirements given in 5.1, 5.2, 5.3 and 5.7.

The number of primary packages to be selected from a lot shall be in accordance with Table 6 of this standard.

Table 6 – Scale of sampling of packaged drinking water

Number of primary packages in the lot	Number of primary packages to be selected
Up to 1000	15
1001 to 3000	17
3001 to 10,000	18
Above 10,000	24

If the primary packages are packed in secondary packages, 10% of the secondary packages subject to a minimum of five secondary packages shall be selected from the lot and as far as possible an equal number of primary packages shall be selected from each secondary package so selected, to form a sample size as given in Table 6 of this standard.

The secondary packages and primary packages shall be selected at random. In order to ensure randomness of selection, tables of random numbers shall be used. In the absence of tables of random numbers, the following procedure shall be used:

Starting from any secondary or primary package in the lot, count them as 1, 2, 3, … etc. up to *r* and so on in one order, r being the integral part of N/n where N is the total number of packages in the lot and n the number of packages to be selected.

Each r^{th} primary or secondary package thus counted shall be drawn and all such packages shall constitute the sample.

7.2.3 Number of tests

Each primary package selected from the lot as given in 7.2.2 shall be inspected for packaging and labelling requirements.

Ten primary packages shall be selected from the secondary packages selected (see 7.2.2) and tested individually for bacteriological limits.

A sufficient quantity of water shall be drawn from each of the remaining primary packages and mixed to form a composite sample and the composite sample thus obtained shall be tested for physical and chemical requirements.

8 Criteria for conformity of drinking water

A lot shall be declared as conforming to the requirements of this specification if the following conditions are satisfied:

8.1 Each primary and/or secondary package inspected for packaging and labelling, as given in 9, satisfies the relevant requirements.

8.2 When tested for bacteriological quality, the water shall conform to the requirements given in 5.3.

8.3 The water samples when tested shall also conform to the physical requirements (see 5.1); chemical requirements (see 5.2) and the additional requirements given in 5.7.

9 Packaging and labelling of packaged drinking water

9.1 Packaging

9.1.1 The material used in the packaging of the drinking water shall meet the requirements in GS 173 for sachet water and GS 1239 for bottled water.

9.1.2 The constituents as well as pigments and colourants used in the manufacture of plastics for packaging drinking water shall meet requirements in GS 595 and GS 598 respectively.

9.1.3 The product (water) shall be filled in clean containers under strict hygienic conditions and shall be hermetically sealed (see 5.7.2.1).

9.1.4 The nominal capacity of packaged drinking water shall be at least 5% less the brimful capacity of the primary package/container and the nominal volume declared.

9.1.5 The containers shall be capable of preventing the possible adulteration or contamination of the product.

9.1.6 The primary packages may be further packed in secondary containers as agreed between the customer and supplier.

9.2 Labelling requirements of bottled/packaged drinking water

9.2.1 Primary packages

9.2.1.1 In accordance with the provisions of LI 1541 Ghana Standards Board (Food, Drugs and other Goods) General Labelling Rules, each primary container shall be marked or labelled indelibly with the following:

a) name of the product (see Annex D for additional information);

b) net volume/nominal volume, in S.I. (metric) units;
c) batch code;
d) date of minimum durability i.e. “BEST BEFORE DATE”; and
e) country of origin.

9.2.1.2 In addition to requirements given in 9.2.1, the primary container shall also be marked with the following:

i) brand or trade name of the product, if any;
ii) name and address of the manufacturer;
iii) GPS location and address of manufacturer’s facility; and
iv) the additional labelling requirements as given in Annex D.

9.2.2 Secondary packages

Secondary packages shall be labelled with the following:
a) name or brand/trade name of the product (see Annex D);
b) number of bottles or packages;
c) volume of each container;
d) country of origin;
e) manufacturer’s name and address;
f) GPS location of manufacturer’s facility; and
g) applicable labelling requirements given in Annex D.

9.3 Labelling prohibitions

9.3.1 No claims concerning medicinal (preventive, alleviative or curative) effects shall be made in respect of the properties of the product covered by this standard. Claims of other beneficial effects related to the health of the consumer shall not be made unless true and not misleading.

9.3.2 The name of the locality, hamlet or specified place may not form part of the trade name unless it refers to ‘water defined by origin’ collected at the place designated by that trade name.

9.3.3 The use of any statement or of any pictorial device which may create confusion in the mind of the public or in any way mislead the public about the nature, origin, composition and properties of the packaged waters put on sale is prohibited.

Annex A
(Normative)

Odour and Taste

A-1 Test by sampler

As the odour and taste of water are not necessary permanent characteristics and may be altered or even lost in transit, it is essential that the sampler tests these properties at the site of sampling and submit his findings in the list of particulars supplied with each sample.

The description of any taste or odour is left to the sampler but, whatever description is given, the sampler shall state whether or not the odour or taste is considered objectionable.

A-2 Laboratory test

NOTE: This test should be carried out by a panel of at least three people

A-2.1 Use a wide-mouth glass-stoppered bottle reserved specially for odour testing. As soon as possible after receipt of the sample, half-fill a prepared odour-free bottle with the sample and insert the stopper. With the sample at a temperature not lower than 15 ºC, shake vigorously for a few seconds, remove the stopper, and check immediately for the presence of any odour.

Check the taste by tasting a little amount of the sample poured from the sampling bottle into a clean beaker.

A-2.2 Record whether or not the odour or the taste or both are considered objectionable.

Compare the results obtained by each member of the testing panel with those recorded by the sampler and, if the results differ greatly, have another observation taken at the sampling point.

Annex B
(Normative)

Determination of Suspended Solids by Filtration through Glass-Fibre Filters

B-1 Principle

Using a vacuum or pressure filtration apparatus, the sample is filtered through a glass-fibre filter. The filter is then dried at 105 ˚C and the mass of the residue retained on the filter is determined by weighing.

B-2 Apparatus

B-2.1 Equipment for vacuum or pressure filtration, to accommodate the selected filters (B-2.2).

NOTE - Equipment for membrane filtration can in most cases be used for other types of filters. The plate supporting the filter should have sufficient permeability to allow the water to pass freely.

B-2.2 Borosilicate glass-fibre filters which contain no binders. The filters shall be circular and of the appropriate diameter to fit the filtering device (B-2.1).

The loss of mass in a blank test shall be less than 0, 3 mg per filter. Preferably the areic mass should be between 50 g/m and 100 g/m^2.

Check the loss of mass during filtration by running the procedure in clause 8, but using 150 ml of distilled water instead of the test sample. Check each box or batch separately. Use three filters, selected at random to increase the sensitivity of the test.

NOTE - To remove water-soluble constituents, the filters may be prewashed. Individual or a small number of filters (< 10) are prewashed by filtering 150 ml of distilled water through the filter(s) and then drying at 105 ˚C for at least 1 h.

Filters may be bulk-washed by soaking in distilled water for several hours. The wash water is drained off and the filter dried at 105 ˚C for at least 1 h or preferably overnight before use.

Glass-fibre filters from different manufacturers can have somewhat different filtering characteristics. State the type of filter used and its manufacturer in the test report (clause B-9).

B-2.3 Drying oven, capable of maintaining a temperature of 105 ˚C ± 2 ˚C.

B-2.4 Analytical balance, capable of weighing to an accuracy of at least 0, 1 mg.

B-2.5 Drying support of suitably surfaced material, to support the filters in the drying oven (B-2.3).

B-3 Reagents

B-3.1 Reference suspension of microcrystalline cellulose, p = 500 mg/l.

Weigh 0,500 g (oven-dry basis) of microcrystalline cellulose $(C_6H_{10}O_5)_n$, of the grade used for thin layer chromatography (TLC), or equivalent, transfer it quantitatively into a 1 000 ml volumetric flask and make up to the mark with distilled water.

The suspension has a shelf life of at least three months.

Shake the suspension well before use.

NOTE - The dry matter content of the microcrystalline cellulose can be determined by drying a separate sample in an oven at 105˚C ± 2°C.

B-3.2 Working reference cellulose suspension, p = 50 mg/l.

Shake the reference suspension (B-3.1) until it is completely uniform. With minimum delay measure (100 ml ± 1 ml) into a 100 ml volumetric flask. Transfer the measured volume quantitatively into a 1 000 ml volumetric flask and make up to the mark with distilled water. Shake the suspension well before use. Prepare a fresh working reference cellulose suspension daily.

B-4 Sampling and sample handling

Obtain samples as described in clause 7. Samples shall preferably be taken in bottles of transparent material. Avoid filling the bottles completely, to allow efficient mixing by shaking the bottle.

Analyse samples for the determination of suspended solids as soon as possible after sampling, preferably within 4 h. Store samples which cannot be analysed within 4 h in the dark at below 8 ˚C, but do not allow the sample to freeze. Interpret results obtained for samples that have been stored more than 24 h with caution. Samples for the determination of suspended solids shall not be preserved by the addition of any additives.

If the time period from sampling to analysis exceeds 4 h, this shall be stated in the test report, as well as the conditions of storage.

B-5 Procedure

B-5.1 Allow the samples to attain room temperature.

B-5.2 Ensure that the filters fulfil the requirement that the mass loss be less than 0, 3 mg per filter (see B-2.2).

B-5.3 Allow a filter to attain moisture equilibrium with the air near the balance and weigh it to the nearest 0, 1 mg using the balance (B-2.4). Take care to avoid dust contaminating the filter, for example by using a desiccator.

B-5.4 Place the filter, smooth side down, in the funnel of the filtering device (B-2.1) and connect the device to a vacuum (or pressure) line.

WARNING -The evacuation of large glass vessels can cause dangerous implosions if the vessel is damaged by scratches etc. Ensure that the relevant safety precautions have been observed.

B-5.5 Shake the sample bottle vigorously and immediately transfer in one stroke a suitable volume of sample to a measuring cylinder.

If the sample is contained in a completely filled bottle, mix the sample by transferring it “back and forth” between two bottles. Check that the second bottle is dry and free from contaminants before use.

Select the sample volume so that the dry residue on the filter will be in the optimum mass range for the determination, which is 5 mg to 50 mg. However, avoid sample volumes exceeding 1 litre. To be valid, the result shall be based on a dry residue of at least 2 mg. Read the sample volume with an accuracy of 2 % or better. Sample volumes of less than 25 ml shall be determined by weighing.

B-5.6 Filter the sample, rinse the measuring cylinder with approximately 20 ml of distilled water and use this portion to wash the filter. Rinse the inner sides of the funnel with another 20 ml portion of distilled water.

If the sample contains more than 1 000 mg/l of dissolved solids, repeat the washing of the filter with three portions each consisting of 50 ml of distilled water. Take care to wash the rim of the filter.

NOTE - The filtering normally is complete within less than 1 min. However, some types of water contain materials that block the filter pores or reduce their diameter. This increases the filtering time and the results can become a function of the sample volume. If such blocking of the filter is observed, the determination should be repeated with smaller volumes. The results should be interpreted with caution.

Release the vacuum (or pressure) when the filter is almost dry. Carefully remove the filter from the funnel with a pair of forceps having flat ends. The filter may be folded if desired. Place the filter on the drying support (B-2.5) and dry it in the oven (B-2.3) at 105 °C ± 2 °C for 1 h to 2 h. Remove the filter from the oven, allow it to attain equilibrium with the air surrounding the balance, and weigh it as before.

B-6 Control run

Repeat the test procedure (clause B-5) using 200 ml of the working reference suspension (B-3.2) as the sample. The recovery shall be between 90 % and 110 %.

B-7 Calculation

Calculate the content of suspended solids ρ, in milligrams per litre, from the equation

$$\rho = \frac{1000(b - a)}{V}$$

where

b is the mass of the filter after the filtration, in milligrams;

a is the mass of the filter before the filtration, in milligrams;

V is the volume of the sample, in millilitres. If the sample has been weighed, consider 1 g of mass as equivalent to 1 ml volume.

Report results in milligrams per litre, to two significant figures.

B-8 Precision

The precision of data for the content of suspended matter, determined as specified in this Standard, depends mainly on the nature of the sample rather than on the method itself. Furthermore, some influence from the particular make of filter used cannot be excluded.

No generally valid data for the reproducibility of the results can be given since it is virtually impossible to perform an inter-laboratory study using authentic waters of relevant types with a guarantee that the subsamples are identical at the arrival in different laboratories. Samples containing living organisms or slimy material (for example carbohydrate polymers) that blocks filters are particularly sensitive to transport and testing conditions.

B-9 Test report

The test report shall include reference to this Standard and the following particulars:

a) date and place of testing;

b) identification mark of the sample tested;

c) the manufacturer and the designation of the filter used;

d) the result;

e) any departure from the procedure (see clause B-5) described in this Annex or any other circumstances that may have affected the results, for example blocking of filters (see the note to B-5.6) and storage time before analysis.

Annex C
(Normative)

Additional Requirements Recommended

C-1 Recommended test methods

The determinants given in Tables C.1 – C.5 can be evaluated with the required accuracy by using the test methods given in the current editions of the following:

- Annual Book of ASTM Standards – Section II: Water and Environmental Technology – Vol. 11.01: Water (1)
- Annual Book of ASTM Standards – Section II: Water and Environmental Technology – Vol. 11.02: Water (II)
- Standards Methods for the Examination of Water and Waste Water. Wash. DC: APHA, AWWA, WEF.
- GS ISO 11885, GS ISO 11423-1/2, GS ISO 10301, GS ISO 10304-1

Table C.1 – Chemical Constituents

Determinant	Requirement
A Inorganic	
Copper (as Cu), mg/L, max	2,0
Sulphide, mg/L, max.	0,05
Dissolved oxygen	**
B Organic	
Toluene, µg/L,max.	0,7***
Xylene, µg/L,max.	0,5***
Ethyl benzene, µg/L, max.	0,3***
Styrene, µg/L,max.	0,02***
Monochlorobenzene, µg/L,max.	10 – 120
1,2-Dichlorobenzene, µg/L,max.	1,0
1,4-Dichlorobenzene, µg/L,max.	0,3
Trichlorobenzene (total), µg/L,max.	5 – 50
2-Chlorophenol, µg/L,max.	0,1 – 10
2,4-Dichlorophenol, µg/L,max.	0,3 – 4,0
2,4,6-Trichlorophenol, µg/L,max.	2 – 300
** The dissolved oxygen content shall not be substantially less than the saturation concentration. *** Concentrations of this substance at or below this health-based value may affect the appearance, taste or odour of the water, leading to consumer complaints.	

Table C.2 – Inorganic constituents of health significance

Constituent	Requirement
Barium (as Ba), mg/L, max	0,7
Cadmium (as Cd), mg/L, max	0,003
Chromium (hexavalent), mg/L, max	0,05
Lead (as Pb), mg/L, max	0,01
Manganese (as Mn), mg/L, max	0,4*
Mercury (total as Hg), mg/L, max	0,001
Molybdenum, mg/L, max	0,07
Nickel (as Ni), mg/L, max	0,02
Selenium (as Se), mg/L, max	0,01
Antimony (as Sb), mg/L, max	0,005
*The concentration of the substance at or above this value may affect the appearance, taste or odour of the water leading to consumer complaints	

Table C.3 – Organic constituents of health significance

Constituent	Requirement
Chlorinated Alkanes	
Carbon tetrachloride µg/L, max	4
Dichloromethane, µg/L, max	20
1,2 -Dichloromethane, µg/L, max	40
1,1,1-Trichloroethane, µg/L, max	2000
Chlorinated Ethenes	
Vinyl chloride, µg/L, max	5
2-Dichloroethane, µg/L, max	50
1,1-Dichloroethane, µgLl, max	30
Trichloroethane, µg/L, max	70
Tetrachloroethane, µg/L, max	40
Chlorinated Benzenes	
Monochlorobenzene, µg/L, max	300*
1,2 -Dichlorobenzene, µg/L, max	1000*
1,4 -Dichlorobenzene, µg/L, max	300*
Trichlorobenzene (total), µg/L, max	20*
Aromatic Hydrocarbons	
Benzene, µg/L, max	10
Toluene, µg/L, max	700
Ethylbenzene, µg/L, max	300*
Styrene, µg/L, max	20*
Benzo [α] pyrene, µg/L, max	0,7*
Miscellaneous	
Di (2-ethylhexyl) adipate, µg/L, max	80
Di (2-ethylhexyl) phthalate, µg/L, max	8
Acrylamide, µg/L, max	0,5
Epichlorohydrin, µg/L, max	0,4
Hexachlorobutadiene, µg/L, max	0,6
Eidetic acid (EDTA), µg/L, max	200
Nitrilotriacetic acid, µg/L, max	200
Tributylin oxide, µg/Lmax	2
*Note that concentrations of these substances at or above the health value may affect the appearance, taste or odour of the water.	

Table C.4 A – Chemical constituents of health significance – Pesticides*

Constituent	Requirement
Aldicarb, µg/L, max	10
Aldrin / dieldrin, µg/L, max	0,03
Atrazine, µg/L, max	2
Carbofuran, µg/L,max	5
DDT, µg/L, max	1,0
1,2-dibromo-3-chloropropane, µg/L, max	1,0
Heptachlor & heptachlor expoxide, µg/L, max	0,03
Lindane, µg/L, max	2
Methoxychlor, µg/L, max	20
Metolachlor, µg/L max	10
Molinate, µg/L, max	6
Permethrin, µg/L, max	20
Propanil, µg/L, max	20
*These pesticides are being used currently in Ghana. The probability that they would contaminate drinking water sources is rather high.	

Table C.4 B – Chemical constituents of health significance – Pesticides**

Constituent	Requirement
Alachlor, µg/L, max	20
Bentazone, µg/L, max	30
Chlordane, µg/L, max	0,2
Chlorotoluron, µg/L, max	30
1,2-dichloropropane, µg/L, max	20
1,3-dichloropropene, µg/L, max	20
Hexachlorobenzene, µg/L, max	1
Isoproturon, µg/L, max	9
4-chloro-2-methyl phenoxy-acetic acid (MCPA), µg/L, max	2
Pendimethalin, µg/L, max	20
Pentachlorophenol, µg/L, max	9
Periodate, µg/L, max	100
Simazine, µg/L, max	2
Trifluralin, µg/L, max	20
2,4-DB, µg/L, max	90
Dichlorprop, µg/L, max	100
Fenoprop, µg/L, max	9
Mecoprop, µg/L, max	10
**These pesticides are known to be present in drinking water in other countries. There is no evidence of their presence in Ghana now. The limits stated are guidelines values. When evidence of their existence is established, appropriate limits would be set.	

Table C.5 – Disinfectants and disinfectant by-products of health significance

Constituent	Requirement
Trihalomethanes	
- Bromoform, µg/L, max	100
- Dibromochloromethane, µg/L, max.	100
- Bromodichloromethane, µg/L, max.	60
- Chloroform,µg/L, max.	200
Chlorite, µg/L, max	700
Cyanogen chloride, µg/L, max	70
2,4,6-trichlorophenol, µg/L, max	200
Di-and trichloroamine+, µg/L, max.	-
Iodine+, µg/L, max.	-
Chlorate,µg/L,max.	-
2-Chlorophenol+µg/L, max.	-
Monochloroacetic acid+, µg/L	-
2,4-dichlorophenol+,µg/L,max	-
Monochloroacetic acid+, µg/L, max.	-
Chloroacetone+, µg/L, max.	-
Chloropicrin+, µg/L, max.	-
Chlorine dioxide++, µg/L, max.	-
+There is no adequate data to permit recommendation of a health guideline value. ++No limit has been established for this compound because of the rapid breakdown of chlorine dioxide and because the chlorite value is adequately protective for potential toxicity from chlorine dioxide.	

Annex D
(Normative)

Labelling Requirements

D-1 Name of the product

D -1.1 The name of the product shall be as follows, depending on its classification in accordance with 4.1 and 4.2

D -1.1.1 Waters defined by origin

Any appropriate name (or names) in the case of waters that comply with the criteria described under 4.1. In the case of blends or mixtures of water from different resources, each resource shall be labelled.

Only 'waters defined by origin', in accordance with this standard, can be presented by names that refer to the origin or give an impression of specific origin. The names used or chosen to represent prepared water shall not apply to 'waters defined by origin' and vice versa.

D -1.1.2 Prepared waters

Any appropriate name (or names) to designate' prepared waters' described in 4.2.

D -1.2 Carbonation

D -1.2.1 The following respective declarations shall appear on the label in accordance with the following criteria:

a) In the case of ground water defined by origin, "*naturally carbonated"* or "*naturally sparkling"* if, after packaging, carbon dioxide spontaneously and visibly is given off under normal conditions of temperature and pressure and the carbon dioxide originates from the source at emergence and is present at the same level as was present originally at emergence, with a possible re-incorporation of gas from the same source, taking into consideration a technical tolerance of ±20%.

b) In the case of ground waters defined by origin, *"fortified with carbon dioxide"* if, after packaging, carbon dioxide spontaneously and visibly is given off under normal conditions of temperature and pressure and the carbon dioxide originates from the source at emergence but is present at a level at least 20% higher than the quantity originally at emergence, with a possible re-incorporation of gas from the same source.

c) In the case of all water, *"carbonated"* or *"sparkling"* if, after packaging, carbon dioxide spontaneously and visibly is given off under normal conditions of temperature and pressure and the carbon dioxide does not entirely originate from the same source as that of the water at emergence.

D -1.2.2 Words such as *"non-carbonated" or* "*non-sparkling*" or *"still"* may apply if, after packaging, there is no visible and spontaneous release of carbon dioxide under normal conditions of temperature and pressure when the package is opened.

D-2 Additional labelling requirements

D-2.1 Chemical composition

The total dissolved solid content of packaged water shall be declared on the principal display panel. With regard to 'waters defined by origin', the chemical composition that confers the characteristics to the product shall also be declared on the label.

D-2.2 Prepared water from a water distribution system

When prepared water is supplied by a public or private tap water distribution system and subsequently packaged, but has not undergone further treatment that would modify its original composition or to which carbon dioxide or fluoride have been added, the wording *"From a public or private distribution system"* shall appear on the label along with the name of the product on the principal display panel.

D -2.3 Treatments

If packaged water has been modified by a permitted treatment before packaging, the modification or the result of the treatment shall be declared on the label.

Annex E
(Normative)

Determination of Iron: 1, 10 - Phenanthroline Photometric Method

E-1 Principle

Addition of 1,10 - phenanthroline solution to a test portion and photometric measurement of the orange-red complex at a wavelength of about 510 nm.

If determining total iron, total acid soluble iron, and total dissolved iron, hydroxylammonium chloride is added to reduce iron (III) to iron (II). If undissolved iron, iron oxides or iron complexes are present, pretreatment is necessary to bring such compounds into solution.

The iron (II) - 1,10 phenanthroline complex is stable in the pH range from 2.5 to 9 and the intensity of the colour is proportional to the amount of iron (II) present. The relationship between concentration and absorbance is linear up to a concentration of 5,0 mg of iron per litre. Maximum absorbance occurs at about 510 nm [molar absorption coefficient 11 x 10^3 l/(mol.cm)].

This method is applicable to the determination of iron concentration between 0, 01 and 5 mg/l. Iron concentration above 5 mg/l may be determined after suitable dilution of the sample.

E-2 Apparatus

All glassware, including sample containers, shall be washed with hydrochloric acid and rinsed with water before use. Usual laboratory equipment, and

E-2.1 Spectrophotometer, prism or grating type, suitable for making measurements at 510 nm or photoelectric absorptiometer fitted with a narrow band pass optical filter having maximum transmission in the region of 510 nm.

E-2.2 Photometric cells, of optical path length at least 10 mm and appropriate to the expected absorbance of the test solution.

NOTE: Cells of longer optical path length are preferable for determining iron concentrations less than 1,0 mg/l.

E-2.3 Membrane filter, average pore size 0,45 µm.

E-3 Reagents

Use only reagents of recognized analytical grade. The water used shall have as low an iron concentration as possible, a measurable iron concentration in the reagents is permissible provided that the lowest concentration to be determined is at least three times the standard deviation of the predetermined results of blank tests. Deionized water or water distilled from an all-glass apparatus has been found to the suitable.

E-3.1 Acetate buffer

Dissolve 40 g of ammonium acetate (CH_3COONH_4) and 50 ml of glacial acetic acid (CH_3COOH) (d = 1,06 g/ml) in water and dilute to 100 ml with water.

E-3.2 Di-isopropyl ether [$(CH_3)_2CH\text{-}0\text{-}CH(CH_3)_2$] (d = 0,72 g/ml) alcohol free, boiling point between 67 °C and 69 °C.

E-3.3 Hydrochloric acid solution, d = 1,125 g/ml c(HCl)≈7,7 mol/L.

E-3.4 Hydroxylammonium chloride, 100 g/l solution.

Dissolve 10g of hydroxylammonium chloride ($NH_20H.HCl$) in water and dilute to 100 ml.

This solution is stable for at least one week.

E-3.5 Nitric acid, concentrated, *sp. gr* 1,40 g/ml

E-3.6 1,10 - phenanthroline solution

Dissolve 0,5 g of 1,10 - phenanthroline chloride (monohydrate) ($C_{12}H_9ClN_2.H_20$) in water and dilute to 100 ml.

Alternatively, dissolve 0,42 g of 1,10- phenanthroline monohydrate ($C_{12}H_8N_2.H_20$) in 100 ml of water containing 2 drops of hydrochloric acid (E-3.3). The solution is stable for 1 week if stored in the dark.

E-3.7 Potassium peroxodisulphate, 40 g/l solution. Dissolve 4 g of potassium peroxodisulphate ($K_2S_20_8$) in water and dilute to 100 ml. The solution is stable for several weeks if store at room temperature in a dark glass bottle.

E-3.8 Iron, standard solution corresponding to 0,10 g of iron per litre. Weigh 50,0 mg of iron wire (purity 99.99%) into a 500 ml volumetric flask. Add 20 ml of water, 5 ml of the hydrochloric acid solution (E-3.3) and warm gently to dissolve. Cool, and make up to the mark with water.

1 ml of this standard contains 0,10 mg of iron. This solution is stable for at least 1 month if stored in a resistant glass or plastic bottle. Commercial iron standard solution may be used.

E-3.9 Sulphuric acid, *sp. gr* 1,84 g/ml

E-3.10 Sulphuric acid solution, c(½H_2SO_4)≈ 4,5 mol/L

Add slowly and with vigorous stirring 1 volume of concentrated sulphuric acid. (E-3.9) to 3 volumes of water while cooling.

E-4 Sampling and preparation of test samples

WARNING - Appropriate safety precautions shall be taken when acidifying samples due to the possibility of release of toxic gases.

E-4.1 Sample

Take the sample in accordance with part 6 of this standard and any specific recommendations for the type of water under examination. Appropriate containers such as polyethylene shall be used.

E-4.2 Total Iron

Acidify the sample immediately after collection to pH 1. In general, 1 ml of the concentrated sulfuric acid is sufficient for 100 ml of sample. If necessary, adjust the pH by addition of the dilute sulphuric acid and take into account any dilution in the final calculations.

E-4.3 Total acid soluble iron and acid soluble iron (II)

Filter the acidified sample (E-4.2) through the membrane filter.

If it is intended to determine iron (II), this filtration should be carried out under an inert atmosphere, for example nitrogen or carbon dioxide, in order to exclude as much air as possible and thus to prevent oxidation of the iron (II).

Fill a glass sample bottle with the filtrate and continue until at least five times the volume has overflowed. Immediately close the bottle with a tightly fitting glass stopper.

E-4.4 Total dissolved iron

To separate dissolved iron from undissolved iron, filter the sample (E-4.1) immediately after collection through the membrane filter and then acidify to pH 1 (See E-4.2)

E-5 Procedure

E-5.1 Test Portion

Take as the test portion, 50,0 ml of the acidified test sample (clause E-4)

E-5.2 Preparation of test solution

E-5.2.1 Total iron

If undissolved iron, iron oxides or iron complexes are present transfer the test portion (E-5.1) to a 100 ml boiling flask and carry out the following pretreatment.

a) Oxidation

Add 5 ml of potassium peroxodisulphate solution (E-3.7) and gently boil for about 40 min ensuring that the volume does not fall below 20 ml. Then cool and transfer it to a one-mark volumetric flask of capacity 50 ml and make up to the mark with water.

NOTE: Alternatively, the mixture may be autoclaved in a 100 ml closed bottle for 30 min, then cooled and diluted to 100 ml. This dilution should be taken into account in calculating the result by multiplying by a factor of 2.

If the solution is turbid after oxidation and before dilution, filter it immediately through the membrance filter (E-2.3) into the volumetric flask. Rinse the filter with a small amount of water adding the washings to the filtrate and make up to the mark with water.

b) Removal of interferences

If removal of interferences is necessary (see clause E-10) proceed as follows:

Transfer exactly 10 ml of the oxidized solution (E-5.2.1 b)) to a 100 ml separating funnel and add 15 ml of the hydrochloric acid solution. Cool and extract three times with 25 ml,10 ml and 10 ml portions respectively of di-isopropyl ether (E-3.2). Combine the ether phases in a second separating funnel and extract twice with 25 ml and 10 ml portions respectively of water. Combine the aqueous extracts and heat cautiously to remove residual ether. Cool, add 0,5 ml of sulphuric acid (E-3.10) and dilute to 50 ml with water.

c) Reduction to iron (II)

Transfer the whole of the solution from E-5.2.1 a) and E-5.2.1 b) to a 100 ml flask and add 1 ml of the hydroxylammonium chloride solution and mix thoroughly. Then add 2 ml of the acetate buffer to bring the pH to between 3,5 and 5,5, preferably 4.5

NOTE: The reduction of iron (III) to iron (II) proceeds most effectively at pH 1. The buffer solution should therefore be added last.

E-5.2.2 Total acid soluble iron and total dissolved iron.

Treat the test sample from either E-4.2 or E-4.3 according to the procedure described in E-5.2.1. If the sample is known to contain only iron in the form of iron (III) the oxidation step may be omitted.

E-5.2.3 Acid soluble iron (II) and dissolved iron (II).

Transfer the test portion (E-5.1) to a 100 ml flask, add 2 ml of acetate buffer and mix thoroughly. The pH of the mixture should be between 3,5 and 5,5, preferably 4,5.

E-5.2.4 Acid soluble iron (III) and dissolved iron (III).

The concentration of acid soluble iron (III) or dissolved iron (III) is derived from the difference between the appropriate concentration of iron determined in E-5.2.2 and the appropriate concentration of iron (II) determined in E-5.2.3.

E-6 Blank test

Prepare a blank test solution using exactly the sample as for the test sample, but replacing the 50 ml of test portion with 50 ml of water.

E-7 Calibration

E-7.1 Preparation of reference solutions

Prepare a series of iron reference solutions to cover a range of concentrations appropriate to the expected iron concentration of the test sample by transferring appropriate accurately known volumes of the iron standard solution (E-3.8) to a series of one-mark volumetric flasks each of capacity 50 ml. Add 0,5 ml of dilute sulphuric acid (E-3.10) to each flask and make up to the mark with water.

Treat a series of iron reference solutions in a similar fashion to the test solutions, according to the appropriate procedure for each form of iron to be determined (see E-5.2).

E-7.2 Formation of the absorbing compound

Add 2 ml of the 1,10-phenantrholine solution to each solution (E-7.1) and place them in the dark for 15 min.

E-7.3 Photometric measurements

Measure the absorbance of the solutions from E-7.2 using the spectrophotometer or the absorptiometer (E-3.1) at 510 nm using water in the reference cell.

E-7.4 Plotting the calibration graphs.

For each series of calibration solutions prepare a calibration graph by plotting the iron concentration of the test solution in milligrams per litre as abscissae against the corresponding measured absorbance as ordinate.

A separate calibration curve is required for each form of iron, for each photometric instrument and for each optical path length of cell.

E-7.5 Frequency of calibration

Check the calibration periodically and especially for each new batch of reagents.

E-8 Determination

E-8.1 Formation of the absorbing compound

To both the test solution (E-5.2) and the blank test solution, add 2 ml of 1,10-phenanthroline solution and place in the dark for 15 min.

E-8.2 Photometric measurements

Measure the absorbance of the solutions from E-8.1 using the spectrophotometer or the absorptiometer (E-2.1) at 510 nm using water in the reference cell.

NOTE - The molar absorption coefficient is 11×10^3 l/(mol.cm).

E-9 Expression of results

E-9.1 Calculation

The iron concentration, l_c , expressed in milligrams per litre, of the sample is given by the equation

Where

f is the slope of the appropriate calibration graph (E-7.4)

A_1 is the absorbance of the test solution (E-8.2)

A_O is the absorbance of the blank test solution (E-8.2)

NOTE - The volume of sulphuric acid added to the sample should be taken into consideration in the calculation.

E-9.2 Reporting the results

Report the results, by indicating the form of iron determined:

a) to the nearest 0,001 mg/l for iron concentrations from 0,010 up to 0,100 mg/l;

b) to the nearest 0,1 mg/l for iron concentrations greater than 0,100 mg/l up to 10 mg/l.

c) to the nearest 0,1 mg/l for iron concentrations greater than 10 mg/l.

E-10 Precision

See the table E.1 below.

Table E.1 - Statistical data on the repeatability of the method

Iron concentration mg/l	Laboratory	Path length[1)] mm	Mean value of 30 results mg/l	Standard deviation mg/l
0,010	1	100	0,010	0,002
	2	-	0,010	0
	3	50	0,010	0,001
	4	10	0,010	0,011
	5	-	0,010	0,000
0,040	5	-	0,041	0,002
0,050	1	100	0,046	0,005
	2	-	0,048	0,004
	3	-	0,045	0,004 6
	4	10	0,048	0,011
0,100	1	50	0,104	0,015
	2	-	0,102	0,004
	3	-	0,096	0,006
	4	10	0,101	0,014
	5	-	0,099	0,006
0,500	1	50	0,48	0,025
	2	-	0,500	0,012
	3	-	0,494	0,005
	4	10	0,498	0,016
1,000	1	10	0,97	0,05
	2	-	1,003	0,008
	3	-	1,009	0,006
	4	10	1,004	0,019
	5	-	1,018	0,004
2,000	1	10	2,05	0,07
	3	-	2,016	0,008
	4	10	1,994	0,017
4,000	1	10	4,02	0,08
	3	-	3,989	0,013
	4	10	3,968	0,033
	5	-	4,003	0,019
5,000	1	10	5,01	0,07
	5	-	5,032	0,015

1) Where no path length is indicated, the path length w as not specified by the laboratory.

E-11 Interferences

Determination of iron concentrations using 1, 10-phenanthroline are relatively free from interferences in comparison with other methods using other reagents. The following should be noted.

Copper, cobalt, chromium and zinc interfere if present in concentrations ten times that of the iron concentration. Nickel interferes if present in concentrations exceeding 2 mg/l. These interferences are avoided by adjusting the pH to between
3,5 and 5,5.

Bismuth and silver precipitate with 1,10-phenantrholine and the test solution must be completely free of their ions. Cadmium and mercury also form precipitates, but if present in low concentrations, appreciable interference is eliminated by adding excess 1,10-phenantroline.

Cyanides interfere with the determination but are usually removed by acidification of the sample except in the case of some complex cyanides.

WARNING - Acidification of samples containing cyanide or sulphide ions must be carried out with care due to the formation of highly toxic vapours.

The acidification of the sample also converts phyrophosphates and polyphosphates to orthophosphates which do not interfere at PO_4^{3-} concentrations up to ten times that of the iron concentration. If higher concentrations are present, isolation of the iron as described in E-5.2.1. b) is necessary.

Aluminium nitrate may be added to displace iron from complexes with certain other anions, such as phosphate, in which form the iron would be slow to react.

Interferences are generally removed by the procedure described in E-5.2.1.b).

NOTE - It is not possible to include details for overcoming all the possible interferences that may be encountered in the application of this method, particularly to highly contamined water and industrial waste water. The method must be adapted according to the type of sample. In some cases, depending on the composition of the sample, an appropriate ashing treatment may be required, for example w et ashing with sulphuric and nitric acids or dry ashing, for example in a furnace at a temperature not exceeding 700 °C. In the present of higher concentrations of chlorides losses of iron can occur.

E-12 Test Report

The test report shall include the following information

a) an identification of the sample;

b) the reference of the method used;

c) the results and the method of expression used;

d) the method of elimination of interferences.

e) any unusual features noted during the determination;

f) any operations not specified in this Ghana standard, or regarded as optional.

Annex F
(Normative)

Determination of Total Dissolved Solids

F-1 Principle

A well mixed sample is filtered through a standard glass fiber filter, and the filtrate is evaporated to dryness in a weighed dish and dried to constant weight at 179 ºC -181 ºC The increase in dish weight represents the total dissolved solids.

F-2 Materials Required

1. Evaporating Dish
2. Water Bath
3. Oven
4. Desiccators
5. Analytical Balance
6. Graduated Cylinders
7. Dish Tongs
8. Gooch Crucibles
9. Filter
10. Vacuum Pumps
11. Crucible tongs
12. Forceps, Smooth-tipped

F-3 Sample Handling and Preservation

Preservation of sample is not practical. Because biological activity will continue after a sample has been taken, changes may occur during handling and storage.

Both the characteristics and the amount of solids may change.

To reduce this change in samples taken for solids determinations, keep all samples at 4 ºC

Do not allow samples to freeze.

Analysis should begin as soon as possible.

F-3.1 Precautions

The following precautions should be observed while performing the test:

- Water samples which contain high concentrations of calcium, chloride, magnesium or sulfate can rapidly absorb moisture from the air.

- Such samples may need to be dried for a longer period of time, cooled under proper desiccation and weighed rapidly in order to achieve a reasonable constant weight

- prolonged drying may result in loss of constituents, particularly nitrates and chlorides.

- Samples with high concentrations of bicarbonate require additional drying at 180 ºC to ensure that all the bicarbonate is converted to carbonate.

F-4 Procedure

- To measure total dissolved solids, take a clean porcelain dish which has been washed and dried in a hot air oven at 180 ºC for one hour.

- Now weigh the empty evaporating dish in analytical balance, (W_1 in mg).

- Mix sample well and pour into a funnel with filter paper. Filter approximately 80 mL - 100 mL: of sample

- Using pipette transfer 0.075 L of filtered sample in the porcelain dish, (V).

- Switch on the oven and allow to reach 105 ºC. Check and regulate oven and furnace temperatures frequently to maintain the desired temperature range.

- Place it in the hot air oven and care should be taken to prevent splattering of sample during evaporation or boiling.

- Dry the sample to get constant mass. Drying for long duration usually 1 hour to 2 hours is done to eliminate necessity of checking for constant mass

- Cool the container in a desiccator. Desiccators are designed to provide an environment of standard dryness. This is maintained by the desiccant found inside. Don't leave the lid off for prolonged periods or the desiccant will soon be exhausted. Keep desiccators cover greased with the appropriate type of lubricant in order to seal the desiccators and prevent moisture from entering the desiccators as the test glassware cools.

- weigh the dish as soon as it has cooled to avoid absorption of moisture due to its hygroscopic nature. Samples need to be measured accurately, weighed carefully, and dried and cooled completely.

- Note the weight with residue, (W_2 in mg).

F-5 Calculation

Weight of residue (mg) $W = W_2 - W_1$

The volume of the sample (L) V =75

Total dissolved solids (mg/L) $TDS = \frac{W}{L}$

Annex G
(Informative)

Bibliography

- Annual Book of ASTM – Section II: Water and Environmental Technology – Vol.II.01: Water (1)
- Standards Methods for the Examination of Water and Wastewater, 20th Ed., 1998, Washington DC; APH, AWWA, WEF.
- WHO – Guidelines for Drinking Water Quality 4th Edition
- ISO 11623: 1997 Water Quality – Determination of suspended solids by filtration through glass-fibre filters