Ensuring Access to Quality Water Services for All

GUIDELINES ON DRINKING WATER QUALITY AND EFFLUENT MONITORING

March 2008

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LIST OF ABBREVIATIONS

BOD_5	Biochemical oxygen Demand
COD	Chemical Oxygen Demand
GS	Galvanized Steel
KS	Kenyan Standards
KEBS	Kenya Bureau of Standards
NEMA	National Environment Management Authority
NTU	Neplelometric Turdidity Units
THM	TriHalo Methane
WHO	World Health organization
WASREB	Water Services Regulatory Board.
WSB	Water Services Board
WSP	Water Service Provider

LIST OF SYMBOLS

Al	Aluminum
Al_2O_3	Aluminum Trioxide
As	Arsenic
Ba	Barium
Ca	Calcium
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
Cl^-	Chloride
CN^-	Cyanide
Co	Cobalt
Cr	Chromium
Cu	Copper
F^-	Fluoride
Fe	Iron
Hg	Mercury
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
NH_3	Ammonia
Ni	Nickel
NO_3^-	Nitrate
Pb	Lead
S	Sulphur
S^{2-}	Sulphur
Se	Selenium
Sn	Tin
SO_3^{2-}	Sulphite
SO_4^{2-}	Sulphate
SS	Suspended Solids
Zn	Zinc

1.0 Water Quality Monitoring

Water quality is one of the main indicators of the quality of service provided to the consumer. Water quality has an impact on both the public health and aesthetic value of water as a consumable product. The Water Act 2002 under section 47 requires WASREB to determine standards for the provision of water services to consumers and to monitor compliance with established standards for the design, construction, operation and maintenance of facilities for water services. For effective monitoring of water quality both internal self monitoring by the WSP and an independent monitoring by the WSB and WASREB is necessary. For example one of the principles in the WHO guidelines on water quality standards is to have separate roles in monitoring by the WSP and that by an independent regulating body. Independent monitoring can also be undertaken by the ministry of Water and Irrigation (MW&I), Kenya Bureau of Standards (KEBS), Ministry of Health (MoH) and the National Environment Management Authority (NEMA). In this regard WSPs, are required to undertake their own monitoring of water quality as part of their quality assurance programme and process control. Experience however has shown that without clear instruction through guidelines some WSPs tend to carry out insufficient number of tests.

1.1 Purpose of the Guideline

The purpose of this guideline is to:

- Promote transparency in the methods of water quality monitoring employed by the WSPs and thus build public confidence in service provision;
- Ensure through regular monitoring that the quality of water provided meets the standards set by KEBS;
- Create awareness among the Water Services Boards (WSBs) and Water Service Providers (WSPs) on the water quality monitoring requirements;
- Ensure that all WSBs and WSPs follow a systematic way of water quality monitoring so as to have uniformity of the process;
- Ensure a minimum standard of water quality monitoring at acceptable costs; and

- Create awareness among consumers that information regarding water quality will be made available by the WSPs.

The guideline contain information on establishing the minimum number of samples to be taken, water quality parameters to be measured, recording and reporting/ publication of results.

The effectiveness of the water quality and effluent monitoring system established through these guidelines is based on five factors:

- Elaboration and application of an appropriate sampling programme (regular planning);
- Costs of water quality monitoring should be reflected in the annual budget;
- Sample collection and preservation;
- Analysis and recording; and
- Reporting and record keeping.

Improper actions in one of these areas will lead to an insufficient number of samples, inaccurate results and consequently wrong perception of the situation on the ground.

In order to ensure adequate understanding and application of these guidelines and their requirements every WSP must have at least an adequately trained responsible person to carry out their water quality programmes. It is imperative that the person in charge understands fully the importance of their duties.

1.2 Sources of Water

The most common sources of water in Kenya are surface and ground water. Rain water is used to supplement domestic and agricultural water; however, it should be noted that in urban areas where industrial activities are high, the rainwater can be acidic.

1.2.1 Groundwater Quality

Composition of groundwater depends on:

- Composition of the soil (humic substances – organic matter – and minerals : Fe^{2+}, Mn^{2+}, NH_3, H_2S, CH_4, HCO_3^-, SiO_2 and F^-);
- Contamination from the surroundings;
- Quality of the water to be infiltrated (rain, surface water); and
- Retention time of the groundwater.

The groundwater composition is affected by human polluting activities, which include agriculture, cattle breeding, industrial and domestic activities. In this case, shallow aquifers suffer most.

To prevent pollution, place a fence around the wells to restrict entry. In more densely populated areas, this measure may not work; hence the following measures can be used:

- Removal of existing industries or by applying stricter regulations/ license for settlement for existing and new industries;
- In agricultural zone, use of permitted chemicals and reduction of manure, pesticides etc; and
- Avoiding and removal of dumps and landfills.

Other more friendly measures include:

- Financial support of farmers by water supply company for use of alternative, harmless chemicals; and
- Demonstration projects of 'groundwater friendly' agriculture.

1.2.2 Surface Water Quality

The natural and human activities that cause change of quality of surface water include:

- Weathering rocks/ erosion;
- Leaching the soil/dissolving materials;
- Decay of organic mater (leaves, branches of trees, which result in humid substances);
- Flooding river banks (high turbidity);
- Industrial and domestic wastes (oils and grease, detergents, radioactive substances, synthetic organic chemicals, inorganic salts etc);
- Agricultural run off (fertilizers, pesticides, herbicides etc.); and
- Thermal wastes (increased temperature from cooling waters).

1.3 Potable Water

The basic requirements for drinking water are that it should be:

- Free from pathogenic (disease causing) organisms;
- Containing no chemicals that have an adverse or long term effect on human health;
- Fairly clear (i.e. low turbidity, little colour);
- Not saline (salty);
- Containing no compounds that cause an offensive taste or smell; and
- Not causing an encrustation of the water supply system not staining clothes washed in it.

Surface water sources rarely meet these requirements without adequate treatment. The treatment processes here are those involving physical, chemical and bacteriological changes so as to transform the raw water to potable water.
The table below gives the recommended treatment process for various raw waters.

Table 1 Guideline Values for Raw water

Coliform organism (Number/100ml)	**Recommended treatment**
0-50	Bacterial quality requiring disinfection only
50-5000 people	Bacterial quality requiring full treatment (coagulation, sedimentation, filtration and disinfection only)
5000-50000 people	Heavy pollution requiring extensive treatment
Greater than 50000 people	Very heavy pollution unacceptable as a source unless no alternative exists. Special treatment needed.

When more than 40% of the number of coliforms are found to be of the fecal category group, the water should be considered to fall into the next higher category with respect to the treatment required.

In order to ensure that WSPs supply potable water, the role of WASREB is to ensure that a specified acceptable minimum standard of practice is followed by every WSP, which includes:-

- monitoring the minimum required number of samples and tests on water supply and effluent discharges;
- collecting data on compliance on standards; and
- ensuring publication of test results.

1.3.2 Criteria for frequency of water sampling

The criteria used for determining the frequency of sampling in these guidelines include:

- Source of the water - whether ground or surface water
- Volume produced and Population served
- Number of tests to be conducted – both bacteriological and physiochemical

1.3.3 Parameters

Limits for all parameters are defined by KEBS and should be seen as binding also in the context of these guidelines (See Annexes 1-5). All the parameters that are required by KEBS must however be checked on as per their requirement.

The required number of samples to be tested is given in the tables 2 and 3. Production figures in these tables refer to the annual production for each particular scheme served by a WSP.

1.3.3.1 Bacteriological Parameters

The bacteriological quality is very essential and should be tested before selection and during operation of the supply. Microbiological parameters can have an immediate and significant impact on human health and must therefore be analysed frequently. For bacteriological tests coliform tests will be used to show presence of bacteria. Upon confirmation a faecal coliform test has to be carried out to check for faecal contamination. Residual chlorine tests are associated with bacteriological parameters as chlorine is used to disinfect the water in the treatment process. Presence of residual chlorine indicates sufficient disinfection but does not specifically measure or quantify presence of bacteria. Therefore, a certain number of coliform tests have to be carried out in addition. The parameters and minimum number of samples to be analysed for the basic routine monitoring are shown in table 1 below.

Table 2: Required number of tests for residual chlorine and bacteriological determination based on volume of water produced

	Number of samples per year per parameter in the network	
	For annual water production <240,000 m^3	For annual water production >240,000 m^3
Bacteriological	12	12 + 1 for each additional 30,000 m^3 above 240,000 m^3
Residual chlorine	48	48 + 1 for each additional 15,000 m^3 above 240,000 m^3

Table 3: Recommended minimum sample numbers for faecal indicator testing in distribution systems.

Population	**Total number of samples per year**
Point sources	Progressive sampling of all sources over 3-to 5 – year cycles (maximum)
Piped supplies	
<5000	12
5000 – 100 000	12 per 5000 head of population
>100 000 – 500 000	12 per 10 000 head of population plus an additional 120 samples
>500 000	12 per 100 000 head of population plus an additional 180 samples

The numbers in the tables represent the minimum number of tests the WSPs have to carry out. The providers are however advised to take more samples if they feel it is required under their local conditions. The providers are obliged to carry out additional tests if any doubt about the quality of the water supplied to the customer or regarding contamination of the source occurs. WASREB may demand additional tests in an event of water borne disease outbreak that may be directly attributed to water services provision.

Where more than one network exists, the number of samples should be distributed over the particular networks, taking the volume of water supplied by the separate networks into account. The number of tests required for each network should be equally distributed over time (i.e. if 208 tests per year are required, 4 samples should be taken every week). Where fluctuations occur in the production figures, WSPs might decide to deviate from this rule and take an appropriate proportional number of samples. In this case the minimum number of samples required per year either according to table 2 or 3 must still be achieved. In such a case however, an explanation has to be given to the WSB and WASREB with the submission of the proposed sampling schedule.

It is also important to check the quality of the water after each major repair job so as to ascertain restoration to previous conditions. In cases where a microbiological test is outside the recommended limit, a sample must immediately be collected to check the validity of the result.

1.3.3.2 Physiochemical parameter

Physiochemical parameters usually do not have an immediate impact on human health. However, some physiochemical parameters are important in giving a guide to the quality of water treated and distributed to the consumers. The required sampling frequency for these parameters is shown in table 4.

Table 4: Required number of tests for physiochemical parameters

Number of samples per year per parameter*	Groundwater		Surface water	
	Water production per year		Water production per year	
	<240,000 m^3	>240,000 m^3	<240,000 m^3	>240,000 m^3
Turbidity, pH, Colour	4	6	12	12 + 1 for each additional 60,000 m^3

				above 240,000m^3
Others**	Every six months***	1	2	4

* The required number of tests per parameter applies to both the network and each source.

** Others refer to parameters as specified in Schedules 1- 4

*** More frequent sampling might be required where there is known or suspected contamination e.g. from industry, agriculture or human settlements

Besides the minimum required number of test at the network and at the source, it is in the interest of the WSP to monitor closely the above mentioned parameters during process control not only to ensure good quality water but also to save costs through optimal dosage of chemicals.

1.3.3.3 Sampling Points

Identification of strategic sampling points within the distribution system is important in ensuring that these are representative of the entire system and at the same time ensuring that particular problem areas are identified. In selecting sampling points the following general selection criteria should be taken into consideration:

- Samples taken have to be representative of the different sources from which water is obtained by the consumers or enters the system;
- Sampling points should include the most unfavorable sources or places in the supply system, particularly points of possible contamination Such as unprotected sources, loops, reservoirs, low-pressure zones, ends of the system etc; and
- Sampling points should be uniformly distributed throughout a network

1.3.3.4 Sample collection

In order to minimize inconsistencies and ensure the accuracy of the process, it is recommended that the sampling should be done by qualified persons in accordance with the Kenya Standard KS 05-459 Parts 2-6.

1.3.4 Preparation of Monitoring Program and Sampling Schedules

All WSPs must elaborate an annual monitoring program, calculate the costs and include it in the yearly budget. A sampling schedule for all networks is part of the monitoring program.

Sampling schedules give the dates as to when and where sampling has to be done and which parameters will be tested. This is an important aspect of planning for water quality monitoring and must be given high priority. The sampling schedules at least for each separate network must be done on an annual basis based on projected production and has to be available for inspection when required. The sampling schedules should be reviewed on a quarterly basis and should be adjusted if the difference between projected and actual production figures exceeds 10 %. Nevertheless, the actual number of tests to be carried out has to follow the requirements of table 2 and 3.

The sampling schedule will be done for routine sampling and should include all the strategic points. However, the reactive sampling in response to queries or other problems occurring will have to be done additionally and cannot be counted as scheduled sample thereby reducing the number of remaining samples required. At the end of the financial year an assessment of the planned schedule will have to be done versus what has happened on the ground. An example of a sample schedule is given in Schedule 9.

1.4 Effluent

1.4.1 Constituents of Waste Water

Wastewater is return water after domestic and industrial use. The constituents of wastewater can be classified into two main categories: Organic and Inorganic wastes.

(i) Organic wastes

These come mainly from domestic wastewater although industries also contribute a substantial amount. Some of these organic wastes are from vegetable and fruit packaging, oils and fat , dairy processing, meat packaging, tanning, paper, synthetic detergents, and fiber wood among others.

(ii) Inorganic wastes

Apart from organic wastes domestic wastewater contains inorganic compounds. Industries are a source of these wastes too. Some industries may introduce inorganic substances such as chromium, mercury, cyanide and copper, which are very toxic to aquatic life. There is however other major types of wastes that do not fit either in the organic and inorganic classification. These are heat (thermal) and radioactive wastes as mentioned earlier, where waters with temperatures exceeding the required values may come from cooling processes used by industry and from thermal power stations generating electricity. Radioactive materials are usually controlled at their source, but could come from hospitals or research laboratories.

Wastewater if not treated properly causes problems in the receiving waters. Some of the problems include Oxygen depletion resulting in deaths of aquatic organisms and adverse effect on human health. Adverse effect on clarity and colour affects the popularity of the water for recreation. Waste discharges may also contain toxic substances, such as heavy metals (lead, mercury, cadmium and chromium) or cyanide, which may affect the use of the receiving water for

domestic purposes or aquatic life. Plant effluents chlorinated for disinfection purposes may have to be dechlorinated to protect receiving waters from toxic effects or residual chlorine.

This guideline serves to assist the WSPs:

- Determine the effluent quality as it is released into the environment;
- Check on the operational efficiency of the wastewater treatment system; and
- Assist WSPs in the monitoring of industrial effluent in their areas.

Once a wastewater treatment system has been commissioned, a routine monitoring and evaluation programme should be established so that its performance could be verified and the actual quality of its effluent established, Compliance with the established discharge standards is then determined.

The results of such a monitoring programme could give early warning on treatment works that have failed to meet their requirements and thus prepare for remedial measures to avoid pollution of the receiving water body.

The evaluation of wastewater treatment performance and behaviour, although a much more complex procedure than the routine monitoring of effluent quality, is nonetheless extremely useful as it provides information on how under loaded or overloaded the system is, and thus by how much, if any, the loading on the system can be safely increased as the service area expands, or whether expansion of the treatment facilities is required. It also indicates how the design of future installations might be improved to take account of local conditions.

1.4.2 Sewer Use Ordinance

Section 76(1) of the Water Act prohibits any trade premises from discharging any trade effluent without the consent of the licencee. In this regard all dischargers of trade effluent will be required to obtain a Sewer Use Ordinance (SUO) permit the application of which shall be made to the licensee and shall state the following:-

a) The nature and composition of the trade effluent;
b) The maximum quantity of the effluent which is proposed to discharge on any one day;
c) The highest rate at which it is proposed to discharge the effluent;
d) Daily effluent fluctuations; and
e) Any other information required by the licensee

It is the responsibility of the industrialist to routinely monitor the quality of effluent being discharged to ensure that it is in accordance with the requirements of schedule 7. The WSP shall from time to time with or without notice monitor the effluent being discharged by the industries to ensure compliance with the standards. . In cases where the effluent does not meet these standards then it is the responsibility of the operator to pre-treat the effluent before discharge. This approach is in line with the "polluter pays principle" currently being developed by NEMA.

1.4.3 Types of Monitoring Programs

A monitoring program will involve some surveillance mechanisms that include: self-monitoring, scheduled monitoring, unscheduled monitoring and demand monitoring. Self monitoring will be undertaken by the industrialist in accordance with the requirements of the SOU permit whereas the others are a responsibility of the WSP.

1.4.3.1 Self Monitoring

Since the WSP may not be able to perform all the various monitoring functions required for industrial contributors, a program of self-monitoring should be implemented. Using this format, each major contributor is required to do its own sampling and analysis. The monitoring frequencies should be listed in the SOU permit as the minimum self-monitoring frequencies that must be performed to meet the requirements of the permit. The permittee may choose to perform monitoring at a greater frequency than specified in the permit, if so desire.

1.4.3.2 Scheduled Monitoring

Scheduled monitoring involves the systematic sampling and inspection by the WSP in accordance with a predetermined schedule. Scheduled monitoring will serve to check for compliance with the ordinance, determine surcharge, user charge, and compliance with WAREB's requirements.

1.4.3.3 Unscheduled Monitoring

Unscheduled monitoring is instituted by the WSP to provide a less formal type of surveillance. Similarly, the WSB can undertake unscheduled monitoring to check wastewater effluent compliance by the various WSPs. Such unscheduled surveillance can be used to randomly survey the entire system over an extended period of time.

1.4.3.4 Demand Monitoring

The WSP conducts demand monitoring when an upset or other disruption of system operation occurs. Such occurrences as explosive or corrosive materials in the sewer, operating difficulties (blockages or plugging in the system), and obvious violation of permit or pre-treatment requirements would require demand monitoring.

1.4.4 Sampling Points

Samples are usually collected at the following points, and a specific designation for each sampling point should be used and marked clearly on the plant, on the sampling bucket and on the bottle.

- Influent (raw sewage) - at a convenient point after screening and detritus removal, but before primary settling, therefore often termed as "screened sewage";

- Effluent from primary settling tanks - a point at the lowest end of the effluent channel to allow thorough mixing;
- Effluent from trickling filters - (for settleable solids tests only);
- Effluent from aeration channels - in case of an activated sludge plant, where a grab sample of mixed liquor is taken;
- Effluent of humus tank or final clarifier - taken from effluent channel if possible;
- Sand filter effluent - from effluent channel or sump;
- Final effluent to stream - which can be from maturation ponds or from river, from grass plots or from reed-beds; and
- Receiving stream - above and below point of discharge, if necessary.

A specific plant may not have all the sampling points mentioned, but sophisticated works may have even more. The points must be arranged so that a uniform and true picture of the performance of each unit of the plant is obtained.

Some WSPs may develop an internal sampling plan or organizational planner to keep them organized and to plan the compliance self-monitoring events. The key to gathering defensible data is to organize and plan a compliance self-monitoring event. A sampling plan should be documented in written form, be user-friendly to the sampling staff and include but not limited to the following items:

- Monitoring point(s) description;
- Sampling methods and protocols;
- Flow monitoring and calibration;
- pH monitoring and calibration;
- Parameters for analyses;
- Appropriate sample containers, preservatives and storage; and
- Sample identification and chain unit should develop specification of custody procedures.

1.4.5 Sample Collection

There are four main methods of sampling, that is; the grab (or spot) sample, composite samples over short periods of time, composite sample over 24 hours, and composite samples over 24 hours in relation to flow. When sampling, care is taken that the sample is taken from the body of the water (flowing or stagnant) and not just from the surface.

The grab sample is normally not representative and can only give a rough idea of the effluent quality at the time of sampling. The composite sample over a short period is better than the grab sample and is more or less representative of the sewage or effluent quality over that period. The composite sample over 24 hours requires that sampling shifts be arranged over the day. The even-sized samples collected hourly or half-hourly and the main sample made up from this after thorough stirring. Composite samples in relation to flow can only be collected if the works has a flow meter and recorder. Samples are best collected separately at intervals of one hour over the sampling period.

1.4.6 Sample Analysis

All laboratories generating water and effluent data must have a recognized certification. Such certification shall be for the test method and the analyte(s) being measured. The laboratories shall ensure that proficiency tests are performed in each matrix/analyte combination (where available) for which certification is sought. In this regard a WSP is not obliged to install and maintain a laboratory capable of carrying out all the required tests. If certain tests are outsourced it is the WSP's obligation to verify that the chosen laboratory is certified and has adequate capacity in terms of trained personnel, and equipment and can maintain an adequate quality assurance system. The WSP should indicate in the sampling schedule which laboratories it uses for the analysis of the different parameters.

1.5 Monitoring for compliance

Each WSP must analyse the results of its water and effluent testing in order to ensure compliance with the Kenya Standards as set out in schedules 1-7.

Compliance for both potable water and effluent will be looked at in two ways:

- Number of tests conducted against number of samples planned according to guideline and
- Number of samples within norm against number of samples tested.

It is the responsibility of the licencee to ensure that the WSPs comply with the requirements of this guideline.

If it is deemed necessary the WSB or WASREB may take a sample to carry out an independent analysis of the sample.

1.6 Reporting System

1.6.1 Reporting by Industries

The industrialists must submit the following reports to the WSP and copies to the WSB:

a) Sample schedules for self monitoring and

b) Monthly and annual report on effluent .

1.6.1 Reporting by WSP

The WSPs must submit the following reports to the Water Services Board and copies to WASREB:

a) Sample schedules for both potable water and effluent; and

b) WSP's monthly and annual report on Water Quality and Effluent monitoring according to Schedule 8 and 10, which includes a summary explanation

highlighting the problem areas (noncompliance) and the corrective measures taken.

For each water or sewage treatment works a sample schedule is required and a WSP monthly and annual report on water quality and effluent testing has to be submitted for each treatment work.

1.6.1 Reporting by WSB

WSBs will submit quarterly and annual reports based on the reports submitted by the WSPs which also includes their specific monitoring records. The report should provide a regional summary of the water and effluent quality in the region. In addition corrective actions taken for the problematic areas highlighted in the WSP monthly reports should be indicated.

1.7 Publication of Resulsts

Since the stakeholders have a right to be informed about water and effluent quality, WASREB as the regulator will publish the results in its annual Water Services Sub-sector performance report

Schedule 1 Aesthetic quality requirements for drinking water and bottled drinking water (Source: Adopted from KS 05-459: Part 1: 1996)

SL .NO	SUBSTANCE OR CHARACTERISTIC	UNIT	DRINKING WATER	BOTTLED DRINKING WATER	METHODS OF TEST
(i)	Colour	True color units	15+	15+	KS 05 – 459
(ii)	Taste and odour		Shall not be offensive to consumers	Shall not be offensive to consumers	KS 05 – 459
(iii)	Suspended matter		Nil	Nil	KS 05 – 459
(iv)	Turbidity	NTU,	5	1	KS 05 – 459

		max			
(v)	Total dissolved solids	mg/1, max	1,500	1,500	KS 05 – 459
(vi)	Hardness as $CaCo_3$	mg/1, max	500	500	KS 05 – 459
(vii)	Aluminum as A_1	mg/1, max	0.1	0.1	KS 05 – 459
(viii)	Chloride as Cl^-	mg/1, max	250	250	KS 05 – 459
(ix)	Copper as Cu	mg/1, max	0.1	0.1	KS 05 – 459
(x)	Iron as Fe	mg/1, max	0.3	0.3	KS 05 – 459
(xi)	Manganese as Mn	mg/1, max	0.1	0.1	KS 05 – 459
(xii)	Sodium as Na	mg/1, max	200	200	KS 05 – 459
(xiii)	Sulphate as SO_4	mg/1, max	400	400	KS 05 – 459
(xiv)	Zinc as Zn	mg/1, max	5	5	KS 05 – 459
(xv)	PH		6.5 to 8.5	6.5 to 8.5	KS 05 – 459
(xvi)	Magnesium as Mg	mg/1, max	100	100	KS 05 – 459
(xvii)	Chlorine concentration	mg/1	0.2+ -0.5	Nil	KS 05 – 459
(xviii)	Calcium as Ca	mg/1, max	250	250	KS 05 – 459
(xiv)	Ammonia (N)	mg/1, max	0.5	0.5	KS 05 – 459
(xv)	Fluoride as F*	mg/l, max	1.5	1.5	KS 05 – 459
(xvi)	Arsenic as As	mg/l, max	0.05	0.05	KS 05 – 459
(xvii)	Cadmium as Cd	mg/l, max	0.005	0.005	KS 05 – 459
(xviii)	Lead as Pb	mg/l, max	0.05	0.05	KS 05 – 459
(xix)	Mercury (total Hg)	mg/l, max	0.001	0.001	KS 05 – 459
(xx)	Selenium as Se	mg/l, max	0.01	0.01	KS 05 – 459
(xxi)	Chromium as Cr	mg/l, max	0.05	0.05	KS 05 – 459
(xxii)	Cyanide as CN	mg/l, max	0.01	0.01	KS 05 – 459
(xxiii)	Phenolic substances	mg/l, max	0.002	0.002	KS 05 – 459
(xxiv)	Barium as Ba	mg/l, max	1.0	1.0	KS 05 – 459
(xxv)	Nitrate as NO_3	mg/l, max	10	10	KS 05 – 459

- The local and climatic conditions necessitate adaptation of Flouride concentration in excess of 1.5 mg/l
- In exceptional cases, a Flouride content of 3mg/l can be acceptable in Kenya.

Schedule 2 Limits for inorganic contaminants in drinking water and bottled drinking water (Source: Adopted from KS 05-459: Part 1: 1996)

SL .NO	SUBSTANCE OR CHARACTERISTIC	UNIT	LIMIT OF CONCENTRATION	METHOD OF TEST
(i)	Arsenic as As	mg/1, max	0.05	KS 05 – 459
(ii)	Cadmium as Cd	mg/1, max	0.005	KS 05 – 459
(iii)	Lead as Pb	mg/1, max	0.05	KS 05 – 459
(iv)	Mercury (total as Hg)	mg/1, max	0.001	KS 05 – 459
(v)	Selenium as Se	mg/1, max	0.01	KS 05 – 459
(vi)	Chromium as Cr	mg/1, max	0.05	KS 05 – 459
(vii)	Cyanide As CN	mg/1, max	0.01	KS 05 – 459
(viii)	Phenolic substances	mg/1, max	0.002	KS 05 – 459
(ix)	Barium as Ba	mg/1, max	1.0	KS 05 – 459
(x)	Nitrate as NO_3	mg/1, max	10	KS 05 – 459
(xi)	Fluoride as F	mg/1, max	1.5	KS 05 – 459

Schedule 3 Limits for organic constituents of health Significance in drinking water and bottled drinking water (Source: Adopted from KS 05-459: Part 1: 1996)

SL .NO	SUBSTANCE OR CHARACTERISTIC	UNIT	LIMIT OF CONCENTRATION	METHOD OF TEST
(i)	Benzene	µg/l, max	10	KS 05 – 459
(iii)	Chlorophenols Pentachlorophenol 2, 4, 6-Trichlorophenol	 µg/l, max µg/l, max	 10 10	KS 05 – 459
(iv)	Polynuclear aromatic hydrocarbons Benzo () p[yrene	 µg/l, max	 0.01	KS 05 – 459
(v)	Trihalomethanes Chloroform	 µg/l, max	 30	 KS 05 – 459

Schedule 4 Limits for radioactive materials in drinking water and bottled drinking water (Source: Adopted from KS 05-459: Part 1: 1996)

RADIOACTIVE MATERIAL		LIMIT IN Bq/l	METHOD OF TEST
(i)	Gross alpha activity	0.1	KS 05 – 459
(ii)	Gross Beta activity	1	KS 05 – 459

Note. Formal guidelines are not set for individual radionuclide but rather the approach is based on screening drinking water for the above.

There is however chemicals that have been excluded in guideline value derivation reasons of which include;

(i) Unlikely to occur in drinking water;
(ii) Occurrence in drinking water is at levels below which toxic effects may occur;
(iii) Not of health concern at levels found in drinking water;
(iv) Available data inadequate to permit derivation of health based guideline value;
(v) Degrades rapidly in the environment and is not expected to occur at measurable concentration in drinking water supplies.

Schedule 5 Microbiological limits for drinking water and containerized drinking water (Source: Adopted from KS 05-459: Part 1: 1996)

SL. NO.	Type of micro-organism	Drinking Water	Containerized Drinking Water	Methods of Test
(i)	Total viable counts at 37^{o}C, per ml, max	100	20	KS 05 – 200+
(ii)	Coliforms in 250ml	Shall be absent	Shall be absent	KS 05 – 200
(iii)	E. Coli in 250ml	Shall be absent	Shall be absent	KS 05 – 200
(iv)	*Staphylococcus aureus* in 250ml	Shall be absent	Shall be absent	KS 05 – 200
(v)	Sulphite reducing anaerobes in 50ml	Shall be absent	Shall be absent	KS 05 – 200
(vi)	*Pseudomonas aeruginosa fluorescence* in 250ml	Shall be absent	Shall be absent	KS 05 – 200
(vii)	*Streptococuus faecalis*	Shall be absent	Shall be absent	KS 05 – 200
(viii)	Shigella in 250ml	Shall be absent	Shall be absent	KS 05 – 200
(ix)	Salmonella in 250ml	Shall be absent	Shall be absent	KS 05 – 200

Schedule 6 Guideline values for discharge into public Sewers [The Environmental Management and Co-ordination (Water Quality) Regulations, 2006]

Parameter	Unit	Guideline value
P^H	P^H	6.0-9.0
BOD (5 days at 20℃) max	mgO_2/l	500
COD, max	mgO_2/l	1000
Colour	Hazen units	<40
Temperature, max	℃	20-35
Total suspended solids	mg/l	250
Total non-volatile solids, max	mg/l	2000
Phenols, max	mg/l	10
Detergents	mg/l	15
Oils/Grease, max – where conventional treatment shall be used	mg/l	10
Oils/Grease, max – where ponds is the final treatment	mg/l	5
Ammonia Nitrogen	mg/l	20
Substances that will be obnoxious to smell		Shall not be discharged into the sewer
Arsenic (As), max	mg/l	0.02
Cadmium (Cd), max	mg/l	0.5
Cyanide, max	mg/l	2.0
Total Cyanide, max	mg/l	2.0
Cobalt (Co), max	mg/l	1.0
Chromium VI (Cr^{6+}), max	mg/l	0.05
Total Chromium (Cr), max	mg/l	2.0
Copper (Cu), max	mg/l	1.0
Mercury (Hg), max	mg/l	0.05
Alkyl Mercury	mg/l	Not Detectable
Phosphates	mg/l	30
Free and saline Ammonia as Nitrogen ($N\text{-}N_4/NH_4$), max	mg/l	4.0
Nickel (Ni), max	mg/l	3.0
Nitrates (NO_3), max	mg/l	20
Lead (Pb), max	mg/l	1.0
Sulphide (S^{2-}), max	mg/l	2.0
Phenols	mg/l	10
Selenium (Se), max	mg/l	0.2
Zinc (Zn), max	mg/l	5.0
Total non ferrous metal, max	mg/l	10
Chlorides (Cl^-), max	mg/l	1000

The following chemicals should not be discharged into sewers: Calcium Carbide, Chloroform, Condensing water, Degreasing solvents, radioactive residues, Inflammable solvents and substances likely to interfere with sewers

Schedule 7 Guideline values for discharge into public water [The Environmental Management and Co-ordination (Water Quality) Regulations, 2006]

Systems Parameter	Unit	Guideline value
1,1,1-trichloroethane	mg/l	3
1,1,2-trichloroethane	mg/l	0.06
1,1-dichloroethylene	mg/l	0.2
1,2-dichloroethane	mg/l	0.04
1,3-dichloropropene	mg/l	0.02
Alkyl Mercury compounds	mg/l	Nd
Ammonia, Ammonium compounds, NO_3 compounds and NO_2 compounds	mg/l	100
Arsenic	mg/l	0.02
Arsenic and its compounds	mg/l	0.1
Benzene	mg/l	0.1
P^H	P^H	6.5-8.5
BOD (5 days at 20□C) max	mgO_2/l	30
COD, max	mgO_2/l	50
Temperature, max	^OC	$\pm 3^oC$ of ambient temperature of the water body
Boron	mg/l	1.0
Boron and its compounds – non marine	mg/l	10
Boron and its compounds – marine	mg/l	30
Cadmium	mg/l	0.01
Cadmium and its compounds	mg/l	0.1
Carbon tetrachloride	mg/l	0.02
Chromium VI	mg/l	0.05
Chloride	mg/l	250
Chlorine free residue	mg/l	0.10
Chromium total	mg/l	2
Cis-1,2-dichloro ethylene	mg/l	0.4
Copper	mg/l	1.0
Dichloromethane	mg/l	0.2
Dissolved Iron	mg/l	10
Dissolved Manganese	mg/l	10
E.coli	Counts/100ml	Nil
Flouride	mg/l	1.5
Flouride and its compounds (marine and non-marine)	mg/l	8
Lead	mg/l	0.01
Lead and its compounds	mg/l	0.1
n-Hexane extracts (animal and vegetable fats)	mg/l	30
Oil and grease		Nil
Phenols	mg/l	0.001
Selenium	mg/l	0.01
Selenium and its compounds	mg/l	0.1
Hexavalent Chromium VI compounds	mg/l	0.5
Sulphide	mg/l	0.1
Simazine	mg/l	0.03
Total Suspended Solids	mg/l	30
Tetrachloroethylene	mg/l	0.1

Thiobencarb	mg/l	0.1
Thiram	mg/l	0.06
Total coliforms	Counts/100ml	30
Total Cyanogen	mg/l	ND
Total Nickel	mg/l	0.3
Total Dissolved Solids	mg/l	1200
Colour	Hazen Units (H.U)	15
Detergents	mg/l	Nil
Total Mercury	mg/l	0.005
Trichloroethylene	mg/l	0.3
Zinc	v	0.5
Whole effluent toxicity		
Total Phosphorous	mg/l	2
Total Nitrogen	mg/l	2

The following chemicals should not be discharged to any watercourse:
Calcium Carbonate, Chloroform, Condensing water, Degreasing solvents and

Schedule 8 WSP's Monthly Report on Water Quality Testing

Name of Water Service Provider:

Category:

Reporting period:

System Description:

Water production to town (m^3/month)	
Number of separate networks	
Water provided through network 1(m^3/ month)	
Water provided through network 2(m^3/ month)	
Please list all the networks	

Report on required and conducted tests:
Is there a monitoring program in place?.....
Networks

Network 1 [Name or description]	**Number of tests planned according to guideline**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Network 2 [Name or description]	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Please list all the networks

Total number of tests in networks	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Treatment Work 1 **[Name or description]**	**Number of tests required per year**	**Number of tests conducted**
Residual chlorine		
Bacteriological		
Turbidity, pH, colour		
Other physio-chemical		
Treatment chemicals for water production	**Quantity**	**Amount Kshs**
Chemica A (please specify)		
Chemica B (please specify)		
Chemica C (please specify)		
Please list all chemicals used		

In case of deviation from No. of planned tests give reasons and state what action was taken:

In case of non-compliance for water quality above acceptable limits of tested samples give reasons and state what action was taken:

Additional comments

Schedule 8 WSP's Annual Report on Water Quality Testing

Name of Water Service Provider:

Category:

Reporting period:

System Description:

Water production to town (m^3/yr)	
Number of separate networks	
Water provided through network 1(m^3/yr)	
Water provided through network 2(m^3/yr)	
Please list all the networks	

Report on required and conducted tests:
Is there a monitoring program in place?.....
Networks

Network 1 [Name or description]	**Number of tests planned according to guideline**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Network 2 [Name or description]	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Please list all the networks

Total number of tests in networks	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
Residual chlorine			
Bacteriological			
Turbidity, pH, colour			
Other physio-chemical			

Treatment Work 1 **[Name or description]**	**Number of tests required per year**	**Number of tests conducted**
Residual chlorine		
Bacteriological		
Turbidity, pH, colour		
Other physio-chemical		
Treatment chemicals for water production	**Quantity**	**Amount Kshs**
Chemica A (please specify)		
Chemica B (please specify)		
Chemica C (please specify)		
Please list all chemicals used		

In case of deviation from No. of planned tests give reasons and state what action was taken:

In case of non-compliance for water quality above acceptable limits of tested samples give reasons and state what action was taken:

Additional comments

Schedule 9 WSP's Sample Schedules for Water Quality Monitoring

Name of Water Service Provider:

Category:

Reporting period:

System Description:

Water production to town [m^3/yr]	
Number of separate networks	
Please include layout showing the sampling points in the system	

	Water provided through network [m^3/yr]	Bacterio-logical tests required	Bacterio-logical tests planned	Residual chlorine test required	Residual chlorine tests planned	pH, turbidity, colour tests required	pH, turbidity, colour tests planned	Other physio chemical tests required	Other physio chemical tests planned
Network 1(please specify)									
Network 2(please specify)									
Network 3(please specify)									
Please list all networks									
Total									

Proposed laboratories for analysis

Bacteriological	
Residual chlorine	
pH, turbidity, colour	
Other physiochemical	

If planned test are not equally distributed over time please give reasons:

Name and qualification of person responsible for water quality monitoring:

Schedule 11 WSP's Annual Report on Effluent Monitoring

System Description:

Amount of effluent discharge (m^3/yr)	
Number of separate networks	
Effluent discharge through network 1(m^3/yr)	
Effluent discharge through network 2(m^3/yr)	
Please list all the networks	

Report on required and conducted tests

Is there a monitoring program in place?.....

Networks

Network 1 [Name or description]	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
BOD_5			
COD			
pH			
Suspended solids			
Ammonia, NH4, Nitrate NO3, Nitrite NO2			
Total Dissolved Solids			
E.Coli			
Total coliform			

Network 2 [Name or description]	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
BOD_5			
COD			
pH			
Suspended solids			
Ammonia, NH4, Nitrate NO3, Nitrite NO2			
Total Dissolved Solids			
E.Coli			

Please list all the networks

Total number of tests in networks	**Number of tests required per year**	**Number of tests conducted**	**Number of tests within Kenya Standard**
BOD_5			
COD			
pH			
Other physio-chemical			

In case of deviation from No. of planned tests give reasons and state what action was taken:

In case of non-compliance for quality of discharged effluent above acceptable limits of tested samples give reasons and state what action was taken:
Additional comments

Schedule 12 WSB's Quarterly Report on Water and Effluent Monitoring

Name of Water Services Board:

Reporting period:

System Description:

Issue	Status
Water production to town [m^3]	
Number of WSPs	
Number of separate networks	
Number of registered effluent dischargers	
Name (s) of laboratories where analysis was carried out	
Number of test conducted	
Number of residual chlorine tests planned according to guideline	
Number of residual chlorine tests within norm	
Number of bacteriological tests planned according to guideline	
Number of bacteriological tests within norm	
Number of chemical tests planned according to guideline	
Number of chemical tests within norm	
Number of effluent tests planned according to guideline	
Number of effluent tests within norm	
Number of overflowing/broken sewers including period of overflow	
Please enumerate measures to put in place to mitigate the above	
If tests carried out are not equal to planned tests, give reasons for deviation	
Summary of major deviations	
Corrective actions undertaken	
Other activities undertaken to improve water and effluent quality	

Schedule 13 WSB's Annual Report on Water and Effluent Monitoring

Name of Water Services Board:

Reporting period:

Issue	**Status**
Water production to town [m^3]	
Number of WSPs	
Number of separate networks	
Number of registered effluent dischargers	
Name (s) of laboratories where analysis was carried out	
Number of test conducted	
Number of residual chlorine tests planned according to guideline	
Number of residual chlorine tests within norm	
Number of bacteriological tests planned according to guideline	
Number of bacteriological tests within norm	
Number of chemical tests planned according to guideline	
Number of chemical tests within norm	
Number of effluent tests planned according to guideline	
Number of effluent tests within norm	
If tests carried out are not equal to planned tests, give reasons for deviation	
Summary of major deviations	
Corrective actions undertaken	
Other activities undertaken to improve water and effluent quality	