

**BHUTAN DRINKING WATER
QUALITY STANDARD, 2016**



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དཔལ་ལྷན་འབྲུག་གཞུང་།
National Environment Commission
Royal Government of Bhutan



March 8, 2016

FOREWORD

Pursuant to the powers granted by the Water Act of Bhutan, 2011, the National Environment Commission hereby adopts the Bhutan Drinking Water Quality Standard, 2016.

The Bhutan Drinking Water Quality Standard has been framed to ensure the safety of the drinking water supplies and the protection of public health. The Standard has been developed in collaboration with the Ministry of Health and the task force members from all the relevant stakeholders.

The Standard sets parameters and maximum allowable limits in the drinking water in Bhutan. It also includes definition of terminologies, the normative references guiding drinking water quality, roles and responsibilities of relevant agencies, monitoring, data management and compliance criteria.

On behalf of the National Environment Commission, I would like to express my deep appreciation to the World Health Organization for its continued support and cooperation.


(Yeshey Dorji)
Vice-chair
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List of abbreviations

BDWQS	Bhutan Drinking Water Quality Standard
BHU	Basic Health Units
MoH	Ministry of Health
MoWHS	Ministry of Works and Human Settlement
NEC	National Environment Commission
NECS	National Environment Commission Secretariat
PHED	Public Health Engineering Division
RCDC	Royal Centre for Disease Control
RWSS	Rural water supply Scheme
SOP	Standard Operating Procedures
WHO	World Health Organization
WSP	Water Safety Plan
WUA	Water Users' Association

1. Introduction

1.1 Need for Bhutan Drinking Water Quality Standard

Bhutan has a population of approximately 745,000 people, of which 70% live in the rural areas. Due to its geographical location, Bhutan is blessed with plenty of water resources with per capita mean annual flow availability of water at 109,000 cubic meters, which is one of the highest in the region. For drinking purposes, water is abstracted from various sources such as rivers, streams, and springs. Groundwater and rain water are rarely used.

Safe, adequate and accessible supplies of drinking water combined with proper sanitation are the essential components of primary healthcare. Insufficient provision of safe drinking water is directly or indirectly related to spread of communicable diseases, increased health risk and environmental pollution. The National Health Survey of 2012 reports that the proportion of Bhutan's population with access to improved drinking water source is 97.7%. However, the report on a rapid assessment of rural drinking water quality which was carried out by the Royal Centre for Disease Control in 2012, showed that only 17% of stream water sources and 28% of spring water sources were safe for use as drinking water¹. This implies that assurance of safe drinking water is still a major challenge in Bhutan.

Since Bhutan has not had drinking water quality standards in the past, the World Health Organisation Guidelines for drinking water quality have been used. Due to the absence of drinking water quality standards, many of the water service providers do not feel the need to carry out water quality testing. As a result, the quality of drinking water is not tested by the water service providers in many Dzongkhags.

In Bhutan, the water supply systems are divided into two categories; the urban water supply system and the rural water supply system. The urban water supply systems are built and maintained by the Municipal corporation and Dzongkhag administration while the rural water supply systems are built through Rural Water Supply Schemes and maintained by the beneficiaries.

With the accelerating development and increase in anthropogenic activities, the quality of raw water sources in Bhutan may be deteriorating. This concern is recognised in Bhutan and there are already a range of policies, guidelines and regulations such as the Rural Water Supply Scheme policy, the Water Act of Bhutan, 2011, the Water Regulation, 2014, the Environmental standard, 2010, and the watershed management

¹ In this context, Safe drinking water refers only to the microbiological quality of drinking water.

guidelines that have been passed to ensure the sustainability and to protect the quality of drinking water sources.

The water used for drinking must be regularly monitored and treated in order to protect the health of the consumers. Therefore, there is an absolute need to develop the “Bhutan Drinking Water Quality Standard”. The need is also expressed strongly in the Water Act of Bhutan, 2011.

The Bhutan Drinking Water Quality Standard describes the quality parameters set for drinking water and the maximum permissible limit for each of the set parameters. Such primary standards protect public health by limiting the levels of contaminants in the drinking water.

1.2 Goal and Objectives

Overall goal:

To ensure safe drinking water to protect consumer health.

Objectives:

- To set safe concentrations of nationally relevant drinking-water parameters.
- To contribute towards a progressive improvement of drinking-water quality management (e.g. sampling, testing, reporting and documentation) by all service providers.
- To strengthen the application of water safety planning in all drinking-water systems.
- To contribute towards increased public awareness of drinking-water safety.
- To build a national drinking-water quality data base.
- To improve accountability of all stakeholders in the provision of safe for drinking-water supply.

2. Terms and Definitions

For the purpose of the standard, the following terminologies shall apply.

- i. **Basic Health Units:** includes BHU grade 1 and BHU grade II.
- ii. **Beneficiaries:** means water users in both rural and urban water supply systems.

- iii. **Certify:** means to attest or confirm in a formal statement.
- iv. **Competent authority:** means the Ministries, Agencies, Local authorities, committees, or any other entity as may be determined by the Commission as the competent authority.
- v. **Disease outbreak:** means the occurrence of cases of water-borne diseases in excess of what would normally be expected in a defined community, geographical area or season.
- vi. **Drinking water:** means water that is suitable for human consumption such as drinking and cooking. It is also called potable water.
- vii. **Drinking Water Quality Standard:** means rules established to control the level of contamination in drinking water under prescribed standard conditions.
- viii. **Dzongkhag Hospitals:** means all hospitals within a Dzongkhag boundary.
- ix. **Groundwater:** means any water located or found beneath the earth's surface in soil pore spaces and in the fractures of rock formations which are called aquifers.
- x. **Institution:** includes a society, organization, or establishment founded for a specific purpose.
- xi. **Maintenance:** means a set of measures and activities aimed at keeping, or restoring the optimal and reliable functionality of equipment that is used to sustain and protect drinking water.
- xii. **Maximum permissible limit:** means the Maximum allowable concentration.
- xiii. **National reference laboratory:** means a leading national laboratory, which has been officially designated for the testing of water quality in Bhutan.
- xiv. **Operational monitoring:** means routine collection and testing of water samples and/or visual inspection of the water supply system to ensure the safety of the drinking water supply by the water service providers.
- xv. **Packaged/bottled water:** means water that is sealed in food grade bottles and intended for human consumption.

- xvi. **Rural:** means any area or settlement outside the declared municipal boundary.
- xvii. **Rural water supply system:** means domestic water supply systems that provide water to rural areas which are designed and constructed to Rural Water Supply System (RWSS) standards.
- xviii. **Safe drinking water:** means water meeting the prescribed microbial, chemical and physical characteristics under the Bhutan Drinking Water Quality Standard (BDWQS).
- xix. **Surveillance:** means a process of monitoring if drinking water supplies conform to the BDWQS conducted by the surveillance body and may include sanitary inspection, water monitoring, data processing, and analysis and reporting.
- xx. **Surveillance body:** means the Ministry of Health, more specifically the Royal Centre for Disease Control, District hospitals, and Basic Health Units.
- xxi. **Thromde:** means a municipality as declared by the Parliament.
- xxii. **The Water Safety Plan:** means effective ways of consistently ensuring safe drinking water supply through a risk assessment and risk management approach to a water supply chain, beginning from its catchment to the consumer point.
- xxiii. **Urban:** means any area or settlement within the declared municipal boundary.
- xxiv. **Urban water supply system:** means a system where water is abstracted from various sources and processed through different treatment units to make water clean, safe and compliant to the BDWQS and distributed within the urban area through a piped network.
- xxv. **Users:** includes water users in both rural and urban areas.
- xxvi. **Water Users' Associations (WUA):** means an Association formed as per Section 50 of the Water Act of Bhutan 2011. WUA are not governed by Civil Society Organization (CSO) Act of Bhutan.
- xxvii. **Water service providers:** means any person or entity, government or private company responsible for source development, water abstraction, treatment and distribution of water. Such entities include the Thromdes, the Dzongkhag Administration and the community organizations in rural areas.

3. Normative Reference

The Bhutan Drinking Water Quality Standard have been developed in accordance with Section 13 (f) and Section 42 (a) and (b) of the Water Act of Bhutan, 2011.

4. Scope

The Bhutan Drinking Water Quality Standard shall apply to all drinking water supplies owned and managed by:

- The Thromde Administration
- The Dzongkhag Administration
- The Gewog Administration
- Chiwogs, Villages, Water Users Associations, Institutions and Household(s)

The standard shall not apply to packaged/bottled water.

Water suppliers have an obligation to provide safe water for consumers. If any parameters or substances are identified in the water which are not specifically included in these regulations and standards, the current edition of the WHO Guidelines for Drinking- water Quality shall be the primary reference to assess the safe level of those substances and parameters.

5. Roles and responsibilities

5.1 Dzongkhag and Gewog Administration

- Prepare and implement a Water Safety Plan (WSP) in their respective jurisdiction.
- Conduct review meetings at least twice a year to ensure consumers are getting safe drinking water.
- Ensure routine operation and maintenance of the drinking water supply system.
- Support advocacy/awareness programmes initiated by relevant agencies.
- Enhance technical capacities to ensure quality construction and operation of the water supply schemes.
- Develop mechanisms to promote community ownership of water supply system.

5.2 Thromde Administration

- Implement plumbing codes of practice with regard to design, installation, construction, testing, operation and maintenance of water supply systems.
- Monitor and evaluate drinking water quality and report to concerned Competent Authorities.
- Develop Standard Operating Procedures (SOP) for monitoring drinking water supply systems.
- In collaboration with Ministry of Works & Human Settlement, develop and implement water safety plans.
- Facilitate drinking water quality surveillance activities.
- Create awareness on water handling procedures at consumer level for safe storage.

5.3 Ministry of Works & Human Settlement

- Ensure safe and adequate drinking water in collaboration with the Dzongkhags and Thromdes.
- Ensure the sustainability of infrastructure for the provision of safe and adequate drinking water in the urban areas.
- Ensure operational monitoring of water quality and report to concerned Competent Authorities through online systems.
- Provide assistance to develop, implement and monitor Urban WSP in Thromdes.
- Carry out WSP assessment or auditing annually for each Thromde.
- Train engineers and technicians working in water sector to provide safe drinking water.

5.4 Ministry of Health

5.4.1 Royal Centre for Disease Control

- Shall be the lead institution to implement the Bhutan Drinking Water Quality Standard.
- Be responsible for Drinking Water Quality Surveillance in Bhutan.
- Continuously strengthen the capacity for monitoring the drinking water quality.

- Serve as the National Reference Laboratory for drinking water quality testing and monitoring.
- Assess and certify the technical competency of drinking water quality testing laboratories.
- Establish and manage centralized drinking water quality database.
- Compile data and submit an annual report to NECS.
- Report to the NECS in the event of non compliance with the standard which may pose a potential threat to consumer health.
- Undertake water quality testing in Thimphu Thromde.

5.4.2 Public Health Engineering Division

- Prepare, implement and carry out advocacy of sound policies, strategies and procedures to support sustainable provision and coverage of rural water supply.
- Provide technical backstopping to Dzongkhags/Gewogs in areas such as design, materials procurement and testing and development of appropriate and affordable technologies for water abstraction and treatment.
- Develop and support the implementation of relevant human resource at the Dzongkhag level.
- Explore alternative technologies to provide safe drinking water.
- Improve the quality of drinking water across the country through implementation of Rural Water Safety Plans.

5.4.3 Dzongkhag Hospitals

- Undertake urban water quality testing in their respective Dzongkhags
- Disseminate water quality test reports within two weeks of sample testing to the water service providers and to the RCDC.
- Ensure that adequate fund is available for procuring water quality testing equipment and reagents and for equipment maintenance.
- Carry out pre-feasibility water quality testing for any new schemes.
- Carry out advocacy and awareness programmes for the consumers on safe drinking water.
- Ensure standard testing equipment are in place/available.
- Provide water quality testing support to the health facilities within its jurisdiction.

- In the absence of a Dzongkhag hospital, BHU Grade 1 shall undertake the above responsibilities.

5.4.4 Basic Health Units

- Conduct testing of rural water supply.
- Carry out pre-feasibility water quality testing for any new schemes.
- Carry out advocacy and awareness programmes on safe drinking water for consumers.
- Maintain water testing facilities to check for compliance with the standard.
- Disseminate water quality test reports within two weeks of sample testing to the beneficiaries and the RCDC.

5.5 National Environment Commission Secretariat

- Ensure implementation and enforcement of the drinking water quality standard.
- Review and revise, as needed the, drinking water quality standard in consultation with relevant stakeholders.
- Publish an annual report on drinking water quality compliance.
- Coordinate meetings among the implementing agencies for the effective implementation of the standard at least once a year.
- Encourage and support programmes to enhance technical capacity in managing drinking water quality.

5.6 Users

5.6.1 Urban Users

- Ensure safe household storage and handling of drinking water supply to avoid contamination.
- Ensure periodic maintenance and cleaning of house hold drinking water storage tanks.
- Provide access to the water storage tanks for monitoring by the relevant agencies.
- Carry out periodic repair and maintenance of household plumbing.
- Report any water borne disease outbreaks to the nearest health facilities for timely interventions.

- Support/facilitate relevant agencies in carrying out water quality survey and testing.

5.6.2 Rural Users

- Ensure safe storage and handling of drinking water supply to avoid contamination.
- Facilitate support to relevant agencies in carrying out water quality testing as deemed necessary.
- Report water borne disease outbreaks to the nearest health facilities for timely interventions.

6. Points of compliance

6.1 Point of compliance – Urban

Any tap connected to the network, or any point within the piped network located before the water meter or at the outlet of any water tanker operated by the water service provider.

Note: The care and safety of the water connection beyond the water meter and other associated fittings are the responsibility of the building owner.

6.2 Point of compliance – Rural

Any tap connected to the network, or any point within the piped network, or any tap connected at the outlet of any reservoir supplied by rooftop rainwater harvesting system.

7. Implementation timeline

This standard will come into effect from 1st July, 2017.

8. Urban Drinking Water Supply

Urban water service providers may apply to NECS for the following:

1. To postpone the starting date for compliance with the provisions of this standard.
2. For exemptions from some of the parameters or frequencies of monitoring.

All exemptions must be specific as to parameter, location and water treatment plant. The urban water service providers must justify the basis of the exemption and provide a timed improvement program to rectify known problems which reasonably make it impossible for the operator to comply with the standard.

The NECS must respond to this request within three months of receipt of the request. Such applications, if granted by NECS, must stipulate a time period after which the exemption will cease. Exemptions may state conditions under which the exemption is granted.

8.1 Table of Parameters and Concentrations

Table -1 Physical Parameters (Urban)

Sl.No	Parameter	Unit	Maximum permissible Limit
1	Colour (TCU)	Hazens Unit	15
2	Odour	-	non-objectionable
3	pH	-	Acceptable range 6.5 – 8.5
4	Taste	-	non-objectionable
5	Turbidity	NTU	5

Table-2 General Chemical Parameters causing undesirable effect (Urban)

Sl.No	Parameter	Unit	Limit
1	Calcium	mg/L	No permissible limit but recommended < 75
2	Free Residual Chlorine*	mg/L	Target range 0.2 – 0.5
3	Iron	mg/L	No permissible limit but recommended < 0.3
4	Manganese	mg/L	0.4* Maximum permissible limit
5	Sulphate	mg/L	No permissible limit but recommended < 250

* Chlorine residual must be maintained throughout the distribution system

Table-3 Chemical Parameters of health concern (Urban)

Sl.No	Parameter	Unit	Maximum permissible Limit
1	Fluoride (to be tested for ground and spring water only)	mg/L	1.5
2	Nitrates	mg/L	50
3	Arsenic	mg/L	0.01
4	Lead	mg/L	0.01
5	Mercury	mg/L	0.006

Table-4 Microbiological Parameters (Urban)

Sl.No	Parameter	Unit	Maximum permissible Limit
1	<i>E.Coli</i>	CFU/100ml sample	0

8.2 Monitoring

Urban Water Service providers should determine the operational monitoring schedule based on their Water Safety Plan. Table 5 gives minimum testing requirements. However, Urban Water Service providers may decide to increase the requirements drawn from Table 5, or they may apply for exemption or modifications based on evidence and risk based analysis.

Table-5 Parameters and Frequency of Operational Monitoring (For urban water Service Providers)

Sl.No	Parameter	Minimum Monitoring Frequency	Treatment Processes Stepwise					
			Raw Water	Coagulation	Sedimentation	Filtration	Disinfection	Distribution
1	pH	Daily	✓			✓		✓
2	Turbidity	Daily	✓			✓		✓
3	Conductivity (indicator parameter)	Weekly	✓					
4	Taste and odour	Weekly					✓	✓
5	Hardness	Annually	✓					
6	Flow rate	Daily	Daily production rates(see note)					
7	Free residual chlorine ¹	Daily						✓

Note: Except for raw water and distribution, all samples are to be tested after the treatment process. Indicator parameters could be used to trigger further investigations if the concentrations change over time.

¹Monitor only in systems using chlorine as disinfectant

Table-6 Parameters and Frequency of Urban Drinking Water Quality Monitoring (for use by the surveillance body)

Sl.No	Parameter	Monitoring Frequency	Sampling Sites	
			Point of exit or entry to the distribution system Disinfection/ Treated Water	Distribution / Sampling stations
1	Colour (TCU)	Monthly		✓
2	Conductivity	Monthly	✓	
3	Odour	Monthly		✓
4	pH	Monthly		✓
5	Taste	Monthly		✓
6	Turbidity	Monthly		✓
7	Calcium	Yearly	✓	
8	Free Residual Chlorine	Monthly	✓	✓
9	Iron	Yearly	✓	✓
10	Manganese	Yearly	✓	
11	Sulphate	Yearly	✓	
12	Fluoride (applicable to ground and spring water only)	Yearly	✓	
13	Nitrate **	Yearly (where surface water source is vulnerable to nitrate sources, frequency to be at least half yearly)	✓	✓
14	Arsenic (applicable to ground water only)	Yearly	✓	
15	<i>E. coli</i>	Monthly	✓	✓

Note: In addition to the above the Surveillance body may monitor samples within a household to ensure that water in households is safe.

If the Surveillance body determines that Lead is of concern, samples should usually be taken from households for verification. If the Surveillance body determines that Mercury is of concern, samples would usually be taken at the exit point of the treatment point or the water source on an annual basis. If the concentrations of these parameters are less than 50% of the limit, then monitoring frequency can be reduced. If the data concludes that these are stable over time then reduced monitoring is acceptable with concentrations of up to 75% of the

8.3 Data management and reporting

8.3.1. Operational monitoring data

- The service providers will maintain and update the water quality test results as per the operational monitoring schedule provided in Section 8.2. The results shall be shared with the MoWHS .
- The MoWHS shall provide timely feedback and technical support on the operational data to the water service providers.
- The MoWHS shall share the operational monitoring data with the RCDC.

8.3.2. Surveillance data

- The Surveillance body shall update the water quality test results as per the surveillance monitoring schedule provided in Section 8.2. The data shall be shared with the water service providers.
- The RCDC shall compile the water quality test data and submit an Annual report to the NECS.
- The NECS shall review and provide feedback on the surveillance data to the RCDC.

9. Rural Drinking Water Supply

9.1 Table of Parameters and Concentrations

Table -7 Physical Parameters (Rural)

Sl.No	Parameter	Unit	Target limits
1	Conductivity	µS/cm	1000
2	Odour	-	Un-objectionable
3	Appearance		Un-objectionable
4	pH	-	6.5 – 8.5
5	Taste	-	Un-objectionable
6	Turbidity	NTU	5

Table -8 Microbiological Parameters (Rural)

Sl.No	Parameter	Unit	Risk Assessment	
1	<i>E.Coli</i>	CFU/ml	0	Safe Water
			1 - 10	Low Health Risk
			11 - 50	Intermediate to High Health Risk
			>50	Grossly Polluted

9.2 Monitoring

- WSP teams or WUAs should ensure that regular operational monitoring of drinking water supply system is carried out consistent with each system's operational monitoring plan.
- The BHUs shall conduct drinking water quality monitoring at least once a year.

9.3 Data management and reporting

- The BHUs shall report to the RCDC.
- The RCDC shall review the results and provide feedback within two weeks of receiving the results from the BHUs.
- The RCDC shall compile and submit an Annual report to the NECS.
- The NECS shall review and provide feedback to the RCDC.

10. Water Safety Plan (WSP)

A Water Safety Plan is an organized and systematic approach to ensure the safety of a drinking water supply, focusing on the key hazards identified from the catchment to the point of use by the consumers, and with the following core objectives:

1. Minimize contamination at the water source;
2. Reduce or remove contamination through treatment processes, and
3. Prevent contamination during storage, distribution and handling;

In accordance with the Water Regulation of Bhutan 2014, service providers shall develop and implement a Water Safety Plan (WSP) for their respective water supply system. The WSP should address normal operating conditions as well as incident or emergency situations. The WSP must also include provisions for review and revision so that the plan remains current and accurate.

The Ministry of Health and Ministry of Works and Human Settlement shall carry out periodic² WSP assessments for:

1. Verifying whether WSPs have been developed in accordance with nationally approved WSP guidance, also if control-measure operational monitoring is being carried as per the WSP, and if the WSP is being reviewed and revised as required.
2. Measuring impact of WSPs on the overall management of water supply systems.
3. Reviewing and revising the WSP implementation strategy from time to time in keeping with changing needs.

² out WSP assessments annually. MoH will carry out WSP assessments once every two years.

11. Surveillance arrangements

The MoH will carry out the water quality surveillance. Surveillance shall be carried out through:

- Sanitary inspection protocols, including sampling and testing.
- Maintaining a database of water quality test results and issues encountered.

12. Compliance

All competent authorities must comply with the BDWQS. In case of non compliance, the Surveillance body shall notify the water service providers for, but not limited to, corrective and restorative measures. In case of failure to comply with the notification for corrective measures within the allotted timeframe given to water suppliers in the urban areas, the Surveillance body shall inform the NECS for necessary action as per the Water Act of Bhutan 2011 and Water Regulation 2014.

In the case of rural water supply, the surveillance body shall first notify the respective Gewog administration. The Gewog administration must then notify the WUA or concerned water users. In case of failure by the water users to comply with the notification, the Gewog administration shall inform the Dzongkhag administration for necessary action.

Note: Guidance note on exceedances under annex 4

13. Revision

The NECS in collaboration with relevant stakeholders may review and revise the standard every five years or as and when deemed required.

14. References

1. The Water Act of Bhutan, 2011, National Environment Commission, Bhutan.
2. The Water Regulation, 2014, National Environment Commission, Bhutan.
3. The Local Government Act, 2009, National Assembly, Bhutan.
4. Annual Health Bulletin, 2014, Ministry of Health, Bhutan.
5. Statistical Yearbook, 2014, National Statistical Bureau, Bhutan.
6. Water Resources Management plan, 2003, Ministry of Economic Affairs, Bhutan.
7. Water Safety Plan Manual, 2009, World Health Organization.
8. Guidelines for Drinking-water Quality, fourth edition, 2011, World Health Organization.
9. Rapid Assessment of Drinking Water Quality of Rural Water Supply Scheme, 2012, Royal Centre for Disease Control, Ministry of Health, Bhutan.

15. ANNEXURES

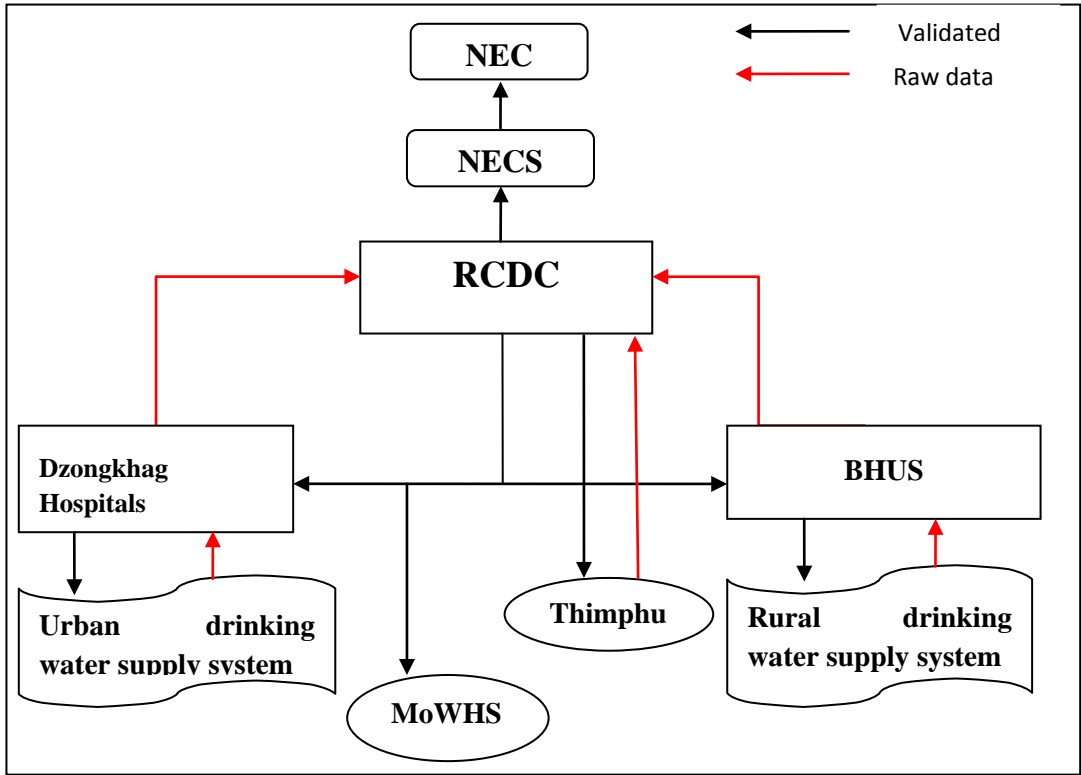
Annex 1: Water sampling method

- i. All precautions shall be taken to prevent contamination of the sample and to ensure that the concentration of the substance being determined does not change between the time of sampling and analysis.
- ii. Samples shall be collected by trained personnel only (e.g. inspectors for drinking water quality surveillance).
- iii. Sampling methods shall comply with ISO **OR** Standard Methods for the Examination of Water and Wastewater (*Joint publication by the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF)*) **OR** the SOP on sample collection drafted by the Royal Centre for Disease Control.

Annex 2: Water testing methods

Analytical methods shall comply with ISO **OR** Standard Methods for the Examination of Water and Wastewater (*Joint publication by the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF)*) **OR** the SOP on sample testing drafted by the Royal Centre for Disease Control.

Annex 3: Surveillance data flow



Annex 4. Technical Guidance on exceedances

1. Guidance following detection of *E.coli* or Thermotolerant coliforms

- i. If *E. coli* is found in a sample an immediate investigation should be undertaken including, but not limited to the following actions:
- ii. Immediate inspection of the drinking water system to identify and rectify any:
 - a. breaks in pipe work and other infrastructure (e.g. tank hatches left open),
 - b. evidence of failure or poor performance of treatment processes. This should include checking disinfectant residuals.

- iii. In systems that use disinfection treatment, concentrations of the disinfectant could be increased. Where practical, chlorination of service tanks or flushing of mains could be considered.
- iv. Immediate collection of additional samples to confirm the presence of *E. coli*, followed by identification of possible sources and extent of the contamination. As a minimum, a repeat sample should be collected from the original sample location, an upstream sample (e.g. a service reservoir) and a downstream sample location.
- v. Where corrective actions are taken, further follow up samples should be collected to verify that corrective actions have been effective.

If *E.coli* is detected in repeat samples, or if faults are identified that could lead to repeat events, the Competent Authority should be notified to enable further action to be determined.

2. Guidance following exceedance of chemical parameters

Exceedance of chemical parameters should be a signal, as a minimum, to:

- i. investigate the cause with a view to taking remedial action as necessary including collecting additional samples as part of the investigation to confirm exceedances and to assess the persistence of the chemical; and
- ii. Consult the authority responsible for public health for advice on suitable action, taking into account the intake of the substance from sources other than drinking-water, the toxicity of the substance, the likelihood and nature of any adverse effects and the practicality of remedial measures.

Note: Chemicals almost invariably require long-term exposure to high levels to cause health-effects and generally, there is a substantial margin of safety built in to guideline values. Therefore exceedance does not necessarily mean health effects and the extent of any health impact depends on the value and duration of the exceedance.

Annex 5. Guidance on Sampling locations and numbers of samples

For microbial parameters, the sampling locations should account for:

- i. locations within the system with long travel times;
- ii. times of increased likelihood of contamination (e.g. seasonal variations or in case of intermittent water supplies); and
- iii. deterioration from outlets of treatment plants (and service reservoirs) to the water distribution system;

It is recommended that sites are rotated amongst designated sample sites throughout the distribution system.

The location of sample sites should provide for good geographic representation of the water supply system and also enable the comparison of water quality over time for particular sections of the system.

Table 9 Recommended minimum sample numbers for faecal indicator testing in distribution Systems

Type of water supply and population	Total number of samples per month
< 5000	5
5000–100 000	5+ 1 per 5000 population
> 100 000–500 000	20+1 per 5000 population

Note: Parameters such as chlorine, turbidity and pH should be tested more frequently as part of operational and verification monitoring.

Name list of taskforce members

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3	Kunzang Rinzin	Legal Officer	Legal Services, NECS
4	Chimmi Dorji	Dy. Chief Laboratory Officer	Royal Centre for Disease Control, MoH
5	Pema Chopel	Laboratory Officer	Royal Centre for Disease Control, MoH
6	Rinchen Wangdi	Chief Engineer	Public health Engineering Division, MoH
7	Nakphel Drukpa	Principal Engineer	Thimphu Thromde
8	Jigme Phuntsho	Executive Engineer	Ministry of Works & Human Settlement
9	Chabi Lal Das	Executive Engineer	Thimphu Dzongkhag
10	Pema Dorji	Asst. Program Officer	Bhutan Standards Bureau
11	Sangay Chedar	Planning Officer	Gross National Happiness Commission
12	Kinzang Tshering	Sr. Program Officer	Department of Local Governance, MoHCA
13	Pasang Wangdi	Sr. Quarantine Officer	BAFRA, Ministry of Agriculture & Forests
14	Tshering Chhophel	Dy. Chief Program Officer	Ministry of Home & Cultural Affairs