



# **Institutional Analysis for Water Quality Testing and Monitoring in Bhutan: Towards Development of A National Reference Laboratory**

**Center for Water, Climate and Environmental Policy**

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## **ACRONYMS**

MoH	Ministry of Health
RCDC	Royal Centre for Disease Control
RSPN	Royal Society for Protection of Nature
BHU	Basic Health Unit
BAFRA	Bhutan Agriculture and Food Regulatory Authority
BDWQS	Bhutan Drinking Water Quality Standard
CNR	College of Natural Resources
ISO	International Organization for Standardization
DoFPS	Department of Forests and Park Services
INSTAAR	Institute of Arctic and Alpine Research
MoAF	Ministry of Agriculture and Forests
MoWHS	Ministry of Work and Human Settlement
NCHM	National Center for Hydrology and Meteorology
NECS	National Environment Commission Secretariat
NSSC	National Soil Services Center
NVE	Norwegian Water Resources and Energy Directorate
RUB	Royal University of Bhutan
RDWQMS	Rural Drinking Water Quality Monitoring System
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
UDWQMS	Urban Drinking Water Quality Monitoring System
USA	The United States of America

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## **1. RATIONALE**

Water quality monitoring and assessment was one of the key issues discussed during the first national water symposium held in May 2017 (Yoezer et al., 2017). The symposium also highlighted that there were many agencies working on various aspects of water resources including water quality in Bhutan.

Many small need based laboratories for water quality testing and analysis have been established in various institutions and agencies mainly for specific purposes such as monitoring, education, projects and research. It was seen that in these laboratories, each agency were following their own laboratory protocols/procedures and there were no common standard practice. Thus, the participants of the symposium felt the need to have an internationally accredited national water quality laboratory in the country.

Therefore, as per the resolutions of the national water symposium 2017, the Ugyen Wangchuck Institute for Conservation and Environmental Research was entrusted to carry out a survey to assess the mandates and capacity of existing agencies dealing with water quality monitoring and testing in Bhutan.

## **2. OBJECTIVES**

The objectives of the assessment were to:

- To assess the mandates and capacity of existing agencies/institutions dealing with water quality monitoring and testing.
- To take stock of the existing facilities in terms of infrastructure, equipment and human resource.
- To rationalize the need for a national reference laboratory for water quality testing and assessment.

## **3. METHODOLOGY**

A semi-structured questionnaire survey was conducted to collect information on water quality testing facilities, institutional mandates and capacities with various stakeholders. The agencies were identified in consultation with the Water Resources Coordination Division of the National Environment Commission Secretariat.

## **4. SURVEY FINDINGS**

### **4.1. Institutions and Mandates**

A total of 13 institutions/agencies having laboratory facilities for water quality assessments was identified. The facilities were established mainly for educational, research and monitoring purposes. However, most of the institutions/agencies did not have a complete set of laboratory facility to conduct comprehensive water quality analysis. There is also a lack of dedicated professionals to perform standardized water quality tests and assessments. Further, the water quality parameters measured by different institutions are driven by specific objective and do not necessarily adhere to the parameters set in the Bhutan Drinking Water Quality Standards, 2016 (NEC, 2016) or the Environmental Standards, 2010 (NEC, 2010).

**Table 1 Institutions and mandates dealing with water quality in Bhutan**

<b>INSTITUTIONS</b>	<b>INSTITUTIONAL MANDATES</b>
Sherubtse College, Royal University of Bhutan (RUB)	For academic, research and consultancy services.
National Center for Hydrology and Meteorology (NCHM)	Mandated to monitor river sediment load and water flow. They are in discussion with NEC to monitor water quality in the streams and rivers of Bhutan.
Royal Society for Protection of Nature (RSPN)	Research, education and environmental conservation.
Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER)	Research, training and policy think tank in areas of forests, biodiversity, natural resources and environmental conservation.
Water and Sanitation Division, Department of Engineering Services (DoES), Ministry of Work and Human Settlement (MoWHS).	The Water Act of Bhutan, 2011 mandates the Ministry of Works and Human Settlement and municipal bodies for ensuring safe, adequate and potable water supply, and proper sewage management in Thromdes;  Bhutan Drinking Water Quality Standard (BDWQS), 2016, requires MoWHS to ensure safe and adequate drinking water in collaboration with the Dzongkhags and Thromdes.
Royal Centre for Disease Control (RCDC), Ministry of Health (MoH)	The Water Act of Bhutan 2011 mandates Ministry of Health to monitor drinking water quality in urban and rural areas.

	The Water Regulation of Bhutan, 2014 entrusts MoH to maintain and periodically update records of physical, chemical and biological parameters with respect to drinking water. The BDWQS, 2016, mandates RCDC to be the lead institution to implement the Bhutan Drinking Water Quality Standard. It also directs RCDC to serve as the National Reference Laboratory for drinking water quality testing and monitoring.
Clean Bhutan (Water keeper Alliance)	A CSO established to study the effect of waste on water system. Monitoring pollution level in rivers of Bhutan.
College of Natural Resources (CNR), RUB	Education and research in terms of water resources and aquatic biodiversity.
National Food Testing Laboratory, Bhutan Agriculture and Food Regulatory Authority (BAFRA)	The Food Act, 2005 mandates BAFRA to implement food control policies and strategies laid down by the National Food Quality and Safety Commission.
Thimphu Thromde	The Water Regulation of Bhutan, 2014 and BDWQS, 2016, mandates thromdes to monitor and evaluate drinking water quality in its respective jurisdiction.
National Environment Commission Secretariat (NECS)	The Water Act of Bhutan 2011 empowers NEC as the highest independent authority to exercise powers and discharge functions under the Act. The commission is required to set national water quality standards and develop procedures for monitoring water quality standards. NECS is also mandated to monitor the state of water resources, compile, analyze and disseminate information.
Soil & Plant Analytical Laboratory, National Soil Services Center (NSSC), Department of Agriculture (DoA)	Mandated to analyze soil and irrigation water quality.
Department of Industry (DoI), Ministry of Economic Affairs (MoEA)	Monitoring authority for industrial waste under the Waste Prevention & Management Act, 2009 and its regulation, 2012. Competent Authority issuing development consent under Environment Assessment Act, 2000.

It was found that none of the institution/agency having water quality testing laboratories/facilities have so far been accredited by ISO or any other international norms. As per the Bhutan Drinking Water Quality Standard (BDWQS) 2016(NEC, 2016), the Royal Center for Disease Control (RCDC) under the MoH is mandated to be the lead institution to implement the BDWQS. The BDWQS, 2016 also authorizes RCDC to serve as the National Reference Laboratory for drinking water quality testing and monitoring in the country.

Most of the agencies such as MoH, MoWHS, MoEA, MoAF, MoHCA, Ministry of Education (MoE), Dzongkhag and Gewog administration and Thromdes are governed by the Water Act of Bhutan, 2011 (RGoB, 2011) as competent authorities for various aspects of water resources management including water quality assessments.

Civil Society Organizations and media houses are also identified as competent authorities as per the Act to assist in prevention of water pollution and sustainable utilization of water resources. The educational and research institutions such as Sherubtse College, CNR, UWICER and civil societies such as RSPN and Clean Bhutan are also mandated to ensure proper utilization of natural resources and conduct re-search, training and advocacy on environmental conservation.

#### **4.2. Existing Laboratory Facilities and Human Resources**

While collating information on the equipment used for water quality testing, we found that different institutions have varying types of equipment/facilities for measuring water quality parameters. However, most of the institutions measured only basic physicochemical parameters such as temperature, pH, conductivity, salinity, turbidity and total dissolved solids.

The National Reference Laboratory for drinking water with the RCDC, Thimphu and Sherubtse College, Kanglung, Trashigang seems to have a comparatively better equipped laboratory facilities as compared to other agencies. The NECS have basic laboratory facility to conduct physical tests as well as some chemical and microbiological tests for ambient and effluent discharge monitoring. The Water and Sanitation Division under DoES, MoWHS and Thimphu Thromde also have basic laboratory facilities to monitor quality of drinking water. The NCHM has tools, which can determine sediment contents and physicochemical parameters but mostly focuses on sediment load in rivers.

The National Food Testing Laboratory with the BAFRA has equipment that can monitor heavy metals and organic contaminants mostly related to ensuring food quality. The DoI

under the MoEA is equipped with basic facilities to monitor industrial wastewater discharges. Likewise, the National Soil Services Center under the DoA has facilities to examine soil and irrigation water quality.

The aquatic biodiversity assessment tool kit with the UWICER can determine diversity of macro-invertebrates in water bodies, which can be also used as bio-indicators for water quality.

Currently, the laboratories are mostly operated by certificate level semi-professional personnel, who have undergone short-term training or gained practical experience through hands-on trainings. The National Reference Laboratory for drinking water with the RCDC has dedicated professionals specialized in water quality assessment, assisted by laboratory technicians. Whereas, most of other agencies have laboratory technicians, but not necessarily trained in water quality monitoring. The details of laboratory facilities, parameters measured and human resources with respective agency/institution are summarized in Table 2.

**Table 2 Laboratory facilities and parameters monitored by institutions**

INSTITUTIONS/ AGENCIES	LABORATORY FACILITIES	EXISTING HUMAN RESOURCES	PARAMETERS MONITORED
Sherubtse College, RUB.	Ion Chromatography (Metrohm), Nutrient Analyzer (Lachat QuickChem500), Shimadzu TOCL, Cavity Ring Down Spectrophotometer (Picarro), pH meter (Acumet), Conductivity meter (Metler Toledo).	2 faculty members with analytical Chemistry cer- tificate pro-gramme	Cations and Anions, Nitrate, Nitrites, Silica, Orthophosphates, Total Phosphorus, Total dissolved phosphorus, Organic carbon, isotopes of water, pH and conductivity.
NCHM	Depth Integrating Sampler, Filtration Flask, Drying Oven, Balances.	1 principal engineer and 13 technicians	Coarse sand content, Fine sand content, Water Depth, Conductivity, Turbidity and water Temperature

RSPN	NA	NA(Seeks assistance from RCDC and other agencies)	NA
UWICER	PCS Test 35 (Multiparameter) probe, Turbidometer Bioindicator (Biodiversity Assessment) Kit.	4 researchers trained on assessing basic physicochemical and bioindicators of water quality	Temperature, pH, Conductivity, Salinity, Total Dissolved Solids, Turbidity, Bio-indicators; Macro-invertebrate assessment.
Water and Sanitation Division, DoES, MoWHS.	Turbidity meter, PH meter, Residual Chlorine meter (in 22 municipalities)	NA (done in collaboration with local government offices)	pH, Turbidity and Residual Chlorine.
National Water Reference Laboratory, RCDC, MoH.	Arsenic Kit, Conductivity/TDS Meter, Del Agua Water Testing Kit, Digital Burette, Digital Burette, Distillation Plant, DO Meter, Electronic Balance, Filter Manifold, Hot Air Oven, BOD Incubator, Oven (Thermolyne), DO Meter, BOD Meter, Ph Meter, pH/ORP meter Photometer, Pipette Washer, Refrigerator, Sample Digester, Turbidity Meter, Vacuum Pump, Arsenic meter, UHPLC (DTL), Autotitrator (DTL), UV-Vis, Spectrophotometer (DTL), Water Deionizer (DTL), Water Deionizer/ Distillation Unit (DTL), In-cubator.	4 laboratory officers and 3 laboratory technicians	Colour, Odour, Taste, Conductivity, Total Dissolved Solids, pH, Turbidity, Calcium, Free Residual Chlorine, Iron, Sulphate, Fluoride, Nitrate, Phosphate, Thermo tolerant, Coliform, Total Hardness, Arsenic, Alkalinity, Acidity, BOD, Yeast and Mould, Other pathogenic organism.

Clean Bhutan (Water keeper Alliance)	Index probe, specific conductance and pH probe, coliert reagent	1 environmental engineer and 2 laboratory as- sistants	Dissolved oxygen, Specific conductance, pH Temperature, E.coli
CNR, RUB.	Multi-tester probe	NA	pH, Total hardness and Dissolved oxy- gen.
National Food Testing Laboratory, BAFRA.	Atomic absorption Spectrometer	6 Laboratory Officers and 7 laboratory technicians	Heavy metals (lead, zinc, cadmium), Total dissolved Solids, pH, Total Alkalinity, Total hardness, Total Colifrom, yeast and mould count, E.coli, aerobic plate count and Salmonella.
Thimphu Thromde	Auto Clave, Total water hardness kit, Conductivity/ Temperature / TDS meter, ELE international Paqualab photometer, ELE international portable, micropres-sor Turbidity meter, ELE Paqualab 50: complete set, Jar test machine, PH/Chlorine comparator, Pocket Pro PH tester	7 lab. techni-cians	Turbidity, PH, hardness, Faecal coliform, conductivity, Temperature, Jar test.

NECS	Rugged Advanced multiparameter test kit ( HACH), Flame Atomic Absorption Spectrometer, Spectrophotometer( UV –Visible ( WL- 190 to 1100nm), SHIM DAZ), Turbidity kit ( HACH), BOD Incubator, Hot Air Oven, Auto Clave, Electronic balance, Arsenic Test Kit (HACH), Refrigerator, Distillation Unit, Desiccators, Del Agua Water Testing Kit, Acetylene Gas Cylinder	2 Laboratory Technicians	pH, Conductivity, Dissolved Oxygen, Total Dissolved Solids, Turbidity, Salinity, Resistivity, Water Temperature, Air Temperature, Oxygen Saturation, Total Suspended Solids, BOD, COD, Total Phosphorous, Total Nitrogen , Fecal Coliform
Soil & Plant Analytical Laboratory (SPAL), NSSC, DoA	Segmented flow Analyzer, Atomic Absorption Spectrometer, pH Meter; Electrical Conductivity meter	2 Laboratory Technicians	pH, EC, Ca, Mg, P, K, Cu, Fe, Mn, and Zn
DoI, MoEA.	BOD Incubator (dysfunc-tional), BOD TrakII Monometric BOD apparatus (dysfucntional), UV- Visible Spectrophotometer, Mercury test kit, TDS Meter, PH me-ter, Digital Balance, Desic-cator	4 Environmental Technicians	BOD, COD, PH, TDS, Heavy Metals (Mercury, Iron total, Zinc total, Cadmium total, Lead total, Chromium, Manga-nese, Fluoride and Sulphate)



**Figure 1. State of the art laboratory facility, Center for Science and Environmental Research, Sherubtse College, Kanglung.**



**Figure 2. Laboratory facilities with Royal Centre for Disease Control, Ministry of Health.**

#### **4.3. Water Quality Assessment Methodology used in Bhutan**

Currently, various methods for water quality assessments are being used by different institutions/agencies based on the type of instruments and human capacity they have. Most of the sampling techniques used were directly dependent on technical expertise of external collaborating institutions.

The NECS, RCDC and NSSC uses standard operating procedure (SOP) developed with reference to the **standard methods for examination of water and wastewater** (20th edition), American Public Health Association and American Water Works Association; and World Health Organization guidelines for Drinking Water Quality (4th edition).

The Water and Sanitation Division follows SOP developed with help from World Health Organization (WHO). NCHM follows standard methods that are being used by Sediment Lab. in Norwegian Water Resources and Energy Directorate (NVE). Clean Bhutan uses method applied by Water Keeper Alliance, an NGO based in the USA and Sherubtse College follows the methodology developed by the Institute of Arctic and Alpine Research (INSTAAR), University of Colorado Boulder, USA.

Thimphu Thromde follows the SOP as specified in the BDWQS, 2016 and agencies like DoI, UWICER and CNR follows methodology as per guidelines specified in user manual

of respective equipment. UWICER has also developed sampling protocol for assessment of macro-invertebrate diversity in collaboration with the University of Montana, USA (Wangchuk & Eby, 2013).

Since most of the institutions are educational, public service or government based, water testing and analytical services are provided for free. The sampling frequency is also reported to differ depending on research projects and fund availability. However, those agencies governed by the Water Act of Bhutan 2011, are reported to conduct water quality monitoring on a regular basis. Recurring annual costs for water sampling and purchase of reagents is reported to be in the range of Nu. 0.5 ~ 2.5 Million. However, the cost would escalate in case equipment breaks down and maintenance is required.

## **5. NEED FOR A NATIONAL REFERENCE LABORATORY IN BHUTAN**

As can be ascertained from discussions in the above sections, currently there is a serious lack of coordination, quality control and standard protocols to guide assessment and monitoring of water quality in Bhutan. There is also limited co-ordination among various agencies for proper utilization of limited facilities and further aggravated issues of shortage of human resources. Most of the stakeholders also recommended that having a well-furnished National Reference Laboratory would reduce cost, time and dependence on external laboratories.

Besides, a standard operating procedure for water quality assessment can be put in place under the National Reference Laboratory. All relevant national institutions can be a collaborative partner to the National Reference Laboratory. This would further enhance professional development, proper utilization of resources and ultimately help in producing comprehensive information on water quality in the country, which can then be used by respective agencies for information dissemination, research and management purposes. This set up may be also replicated in all Dzongkhags housed under relevant stakeholders to extend its service in monitoring drinking water quality and for education, research and outreach purposes.

## **6. ACTS, RULES AND REGULATIONS ON WATER QUALITY ASSESSMENT**

The Water Act of Bhutan, 2011 designates the NEC as the highest independent authority to exercise powers and discharge functions under the Act. With regard to water quality, the commission is required by the Act to set national water quality standards and develop procedures for monitoring water quality standards. NECS is also mandated to monitor the state of water resources, and compile, analyze and disseminate information thereon.

The Act also entrusts MoH as a competent authority for monitoring quality of drinking water both in urban and rural areas. Other competent authorities responsible for managing different aspects of water resources at various levels are; MoWHS, MoAF, MoEA, Bhutan Electricity Authority, MoHCA, MoE, Dzongkhag and Gewog Tshogdu, Civil Society Organizations and media houses.

The Water Regulation of Bhutan 2014 (NEC, 2014), further specifies the roles and responsibilities of each designated competent authorities. The MoH is the competent authority to assist NECS in developing and revising drinking water quality standards and imparting necessary training to relevant stakeholders. The MoAF is focal for irrigation system, watershed and wetland management. MoAF functions as an authority for developing and ensuring water quality standards for irrigation. However, as water quality encompasses every aspects of water management, every competent authority has pivotal role in ensuring overall water security.

The NEC adopted the Bhutan Drinking Water Quality Standard (BDWQS), 2016, as per the Water Act of Bhutan, 2011. The BDWQS was developed in collaboration with MoH and other relevant stakeholders. It has set maximum allowable limits of water quality parameters to ensure safe and healthy drinking water for people of Bhutan.

The BDWQS, 2016 also specifies roles and responsibilities of each stakeholder. It specifically states that the RCDC under the MoH shall be the highest surveillance body to monitor drinking water quality and lead the BDWQS, 2016. With this, the RCDC is required to set up a state of the art laboratory facility, which shall serve as the National Reference Laboratory for drinking water quality testing and monitoring.

RCDC is also required to establish a central database on drinking water quality and has authority to certify technical competency of drinking water quality testing laboratories. Dzongkhag Hospitals and Basic Health Units have to support the RCDC in assessing drinking water quality within their respective jurisdiction. As such, BDWQS, 2016 takes care of all aspects of drinking water quality.

## **7. DISCUSSIONS AND WAY FORWARD**

The Water Act of Bhutan, 2011, the Water Regulation of Bhutan, 2014 and subsequent development of Bhutan Drinking Water Quality Standard (BDWQS), 2016, has led to establishment of clear set of procedures and institutional mechanisms to evaluate and monitor drinking water quality in Bhutan. As per the BDWQS, the RCDC under the ministry of Health is identified as the lead agency in assessing drinking water quality in Bhutan. The RCDC is also to serve as National Reference Laboratory for drinking water quality testing and monitoring with support from Dzongkhag hospitals and Basic Health Units. The RCDC

has already set up monitoring systems such as the Urban Drinking Water Quality Monitoring System (UDWQMS) and Rural Drinking Water Quality Monitoring System (RDWQMS). However, RCDCs mandate is restricted only for monitoring and evaluating drinking water.

Different levels of water quality testing laboratories exist in different institutions within Bhutan, which is mainly driven by respective institutional mandates and specific needs for conducting research, monitoring, educational and outreach programs in absence of a central reference laboratory.

Various agencies are dealing with different aspects of water governance and management in Bhutan such as monitoring, conservation, research, education and outreach programs, thus the justification for existence of different levels of laboratory facilities. Accordingly, the need of equipment and expertise also differs. For instance, parameters and expertise required for evaluating drinking water quality may differ from those required for assessing water bodies for research and conservation efforts. Water quality can also be assessed based on biotic indicators such as presence of aquatic plants and macro-invertebrates.

Most of the survey respondents reported that there is a need of standard and coordinated mechanisms for water quality monitoring and assessment in Bhutan. Thus, there is a need for strengthening the roles of RCDC as National Reference Laboratory for Water Quality Assessment. The RCDC should also take leadership and organize stakeholder consultation workshop among different institutions dealing with water quality and other aspects and discuss on the way forward. These will also help in strengthening the national database on water quality maintained with the National Reference Laboratory, which in turn can serve wider purposes.

## **8. RECOMMENDATIONS**

Based on the findings of the survey we would submit the following recommendations:

1. Strengthen the enforcement of provisions (especially water quality) in the Water Act of Bhutan 2011, Water Regulation of Bhutan 2014 and Bhutan Drinking Water Quality Standard 2016.
2. Strengthen and capacitate National Reference Laboratory for drinking water quality testing and monitoring established under the Royal Center for Disease Control.
3. The National Reference Laboratory to develop standard operating procedures (SOPs) for water quality testing in Bhutan and provide training to relevant stakeholders.
4. District level laboratories may be set up in each Dzongkhags under the supervision of National Reference Laboratory. It can cater to need of water quality information for stakeholders in each Dzongkhags.
5. Establish national data repository on water quality in Bhutan and institute a mechanism on sharing water quality information among stakeholders.
6. The National Environment Commission Secretariat in consultation with relevant

stakeholders may also institute mechanisms to evaluate water quality parameters to ensure health of river systems, wet-lands, aquatic ecosystems and water used for various other purposes.

## **9. ACKNOWLEDGEMENT**

We would like to extend our sincere gratitude to focal persons of all the organizations who took part in the questionnaire survey. We thank Mr. Dhendup Tshering, Lecturer, Sherubtse College and Mr. Chimmi Dorji, Dy. Chief Laboratory Officer, Royal Centre for Disease Control for sharing laboratory pictures for inclusion in the report. We also acknowledge Mrs. Tenzin Wangmo and Mrs. Tshewang Lhamo, Water Resources Coordination Division of the NECS for their inputs for the report.

## **10. ANNEXURE I. SURVEY QUESTIONNAIRE**

1. Name of Agency/ Institution:
- 

2. Name, Designation & contact details of the person filling the form:
- 

3. List the specific mandates pertaining to Water quality testing & monitoring in your agency/institution? Attach a copy of the cabinet order / Govt. Circular or mention the Act/ Regulation providing the mandates.
- 

4. Do you have equipment/Laboratory facilities to conduct water quality tests? If Yes, answer the following questions:

- i. List the type of Equipment available & its function (please provide answer in a separate sheet)
  - ii. List the Parameters measured (please provide answer in a separate sheet)
  - iii. What is the Standard method followed by the Laboratory while conducting tests?
  - iv. Has the Laboratory been accredited?
  - v. Do you see any scope for expansion?
  - vi. How many water samples are tested in a year?
  - vii. What is the total annual budget for running the Laboratory facility?
  - viii. Does the Agency/institution charge for conducting water quality tests?
-

5. List the number and qualification of Lab Technicians/Officers involved in the water quality testing and monitoring in your agency.
- 

6. High light any critical issues and challenges in terms of existing set up for water quality testing and monitoring in Bhutan.
- 

7. Do you think there is a need to have a National Reference Laboratory for the country? If Yes, provide suggestions.
- 

8. Any other suggestions/comments.
- 

## **11. ANNEXURE II. SURVEY RESPONDENTS (AGENCIES)**

1. Dhendup Tshering, Lecturer, Sherubtse College, Royal University of Bhutan
2. Tandin Wangchuk, Engineer, National Center for Hydrology and Meteorology
3. Tsheten Dorji, Project Officer, Royal Society for Protection of Nature
4. Norbu Wangdi (PhD), Dy. Chief Forestry Officer, Ugyen Wangchuck Institute for Conservation and Environmental Research
5. Dechen Yangden, Chief Engineer, Water and Sanitation Division, Department of Engineering Services, Ministry of Work and Human Settlement
6. Chimmi Dorji, Dy. Chief Laboratory Officer, Royal Centre for Disease Control, Ministry of Health
7. Shristi sharma, Wangchu Water keeper, Clean Bhutan
8. Sonam Moktan, Laboratory Assistant, College of Natural Resources, Royal University of Bhutan
9. Letro Tshering, Laboratory Officer, National Food Testing Laboratory, BAFRA
10. Nakphel Drukpa, Principal Engineer, Thimphu Thromde
11. Passang Dema, Environment Technician, National Environment Commission Secretariat
12. Jamyang, Specialist, Soil & Plant Analytical Laboratory, National Soil Services Centre, Department of Agriculture
13. Dawa Chogyel, Chief / Environment Analyst, Department of Industry, Ministry of Economic Affairs

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