Terms of Reference

DEVELOPMENT OF NEEDS ASSESSMENT AND DESIGN OF AIR QUALITY MONITORING NETWORK

(Contract ID No: PPCR/DHM/S/CQS-36)

December 2015

1. Introduction

This Terms of Reference (ToR) is for an international consulting firm to identify the development needs in air quality monitoring network, related laboratories, procedures and institutional framework in Nepal to monitor basic air quality parameters, and to support and strengthen the existing capacity of the Department of Hydrology and Meteorology (DHM) in air quality monitoring. Further the consulting firm is to design the monitoring system as a pilot project and provide initial training on international best practices in air quality monitoring. The scope of work includes the monitoring of air quality on selected locations as pilot stations.

2. Background

There is significant evidence that exposure to air pollution in Nepal is causing serious health and environmental impacts, particularly in urban areas. Available data demonstrate that ambient air quality in major cities, especially in Kathmandu, Biratnagar, and Pokhara is frequently above international health standards.

Air quality monitoring in Nepal is insufficient in terms of measured pollutants, quality of instruments, quality of data, number of monitoring stations and frequency of sampling. Although ambient air concentration data for common pollutants causing health impacts are frequently missing and the coverage of operational measurement network is not sufficient, available data indicates severe exceedance of international air pollution standards set for example by World Health Organization (WHO), European Union (EU) and World Bank (WB).

Nepal's air quality ranks 177th out of 178 countries, according to Yale's 2014 Environmental Performance Index (EPI) scoring 16,23 out of 100 points provided for air pollution, better only than Bangladesh. Particulate matter ($PM_{2,5}$ average exposure and exceedance) and indoor air pollution are taken as indicators for the air pollution in EPI. Recently a study was carried out by Central Department of Economics, Tribhuvan University, South Asian Network for Development and Environmental Economics (SANDEE), to provide an estimate of health benefit to the residents of Kathmandu from a reduction of air pollution level. It also analyzed the monetary costs of the treatment of air pollution related disease.

The main sources of air pollution in Kathmandu are transportation vehicles, valley's brick kilns, and industries. Other sources of air pollution are domestic cooking fuels, refuse burning, and re-suspended dust particles. In addition, the increase in power cuts have now led to increase in usage of diesel generator (DG) sets as an alternative source of electricity in industries, commercial and noncommercial sectors, which is contributing to air pollution in the valley. Preliminary findings of a study on a diesel power generation is Kathmandu Valley shows that around 66.5% of the total diesel sold in Kathmandu Valley in 2012/13 was used for generating electricity from DG sets totaling to nearly 71,000 kl and this emitted nearly 400 tonnes of PM10. The commercial sector (hotels, restaurants, shopping malls, banks etc.) was found to be the largest source of emissions from diesel power generation accounting to around 77% of total PM10 emissions. The emission from diesel generator is significantly high during the dry season when load shedding is at its peak. (*source: Clean Air Network Nepal/Clean Energy Nepal*)

A study done by the World Bank in 1993 estimated that the contribution of vehicle exhaust emissions to Total Suspended Particulate emissions was only 3.5 percent compared to contribution of Himal Cement Factory emissions (36%), brick kilns emissions (31%) and domestic fuel combustion emissions (14%). Nevertheless, it is clear that traffic emissions have more contribution to the particulates ambient air concentrations than indicated by contribution to the emissions. Moreover, the situation in Kathmandu has been changed dramatically since 1993. The Himal Cement Factory along with other different industries have been closed for different reasons and many people use less polluting cooking fuels like kerosene and LPG instead of biomass. But in the meantime, the number of vehicles in the valley has increased threefold. The emission from the vehicles has therefore probably increased significantly, while emission from other sources might have decreased over the past 10 years. As a result, the importance of vehicle emissions to the air quality has most probably increased.

In addition to health effects, air quality monitoring is also important from the perspective of understanding climate trends and influence on the Himalayan cryosphere. In particular, absorbing aerosols originating from incomplete combustion processes (such as small scale burning and vehicle exhaust) are known to warm both the atmosphere and the Himalayan cryosphere. Contributing to harmful PM mass, controlling the emissions of absorbing aerosols (which include e.g. black- and brown carbon) is seen as a desirable way of mitigating harmful health effects as well as climate chance.

To address these environmental issues, as part of the World Bank funded Building Resilience to Climate Related Hazards (BRCH) project, DHM intends to establish **Environmental Monitoring Network for Basic Air Parameters.**

3. BRCH Project

The objective of the BRCH project is to enhance government capacity to mitigate climate related hazards by improving accuracy and timeliness of weather and flood forecasts and warnings for climate vulnerable communities, as well as developing Agricultural Management Information System (AMIS) services to help farmers mitigate climate related production risks. The project comprises four components:

A. Institutional strengthening, capacity building and implementation support of DHM;

B. Modernization of observation networks and forecasting;

C. Enhancement of the service delivery system of DHM; and

D. Creation of an agriculture management information system (AMIS).

Component A aims to develop and/or strengthen DHM's legal and regulatory frameworks, improve institutional performance as the main provider of weather, climate and hydrological information for the nation, build capacity of personnel and management, ensure operability of the future networks, and support project implementation. Component B aims to modernize DHM observation networks, communication and ICT systems, improve hydro meteorological numerical prediction systems and refurbish DHM offices and facilities. Similarly, Component C aims to enhance the service delivery system of DHM by creating a public weather service that provides weather and forecasts impact, and information services for climate-vulnerable communities and the key weather dependent sectors. Component D will provide critical and timely agro-climate and weather information as well as agro-advisories to farmers in order to increase productivity and reduce losses from meteorological and hydrological hazards.

A subcomponent of the component A of PPCR project envisages the development of a needs assessment and design for air quality monitoring network; Pilot operation of air quality monitoring network under the subcomponent of component B expects a modernized environmental monitoring system.

The expected outcomes of the piloting activities are:

- Resource optimization for effective environmental monitoring system;
- Identification of the most effective and reliable monitoring/sampling equipment with real time data acquisition;
- Development of an user-friendly interface as decision support system (DSS) for the data acquisition, management and dissemination of data, forecast and early warning information to concerned agencies and individuals including participating communities; and

- Disseminating long-term environmental data for timely assessment and evaluation of pollution levels, trends and impacts.

4. Status of Air Quality Monitoring System in Nepal

Air quality measurement was initiated by DHM at one of its synoptic stations in the 1980s, which has been discontinued. Air quality monitoring program in the Kathmandu valley was initiated in 2002 by the Ministry of Environment with support from the Danish Government with a network of six stations. The system was partially successful to obtain data for some period.

5. Objective of this Consultancy

The main objective of this consultancy is to design an **Environmental Monitoring Network for Basic Air Quality Parameters.** The assignment will also include preparation of draft specifications and tender documents for observation equipment, related ICT and other components needed for pilot operation. The objectives are mainly:

- Needs assessment in the field of air quality monitoring;
- Preliminary assessment of air quality levels in Nepal;
- Design of a modern air quality observation system based on international best practices;
- Preparation of specifications for pilot air quality observation system under PPCR project;
- Proposal for linking the air quality measurements with the DHM data management systems;
- Institutional analysis, including an initial plan for operation, maintenance, station calibration and data management.

6. Scope of work

The scope of work under this Terms of Reference is for the needs assessment and design of the air quality monitoring network in Nepal. The work will commence with defining the current state of the air quality management and monitoring in the country. As the basis for the design the objectives of the air quality monitoring network and efficient air quality management will be defined in cooperation with the Client. With the support of Client the Consultant will identify the main emission sources, source categories and main pollutants affecting the air quality in Nepal. For supporting the design, the best-international-practices on designing air quality monitoring networks will be taken into account, including the legislative requirements for air quality management and monitoring in Nepal and Internationally (for example EU Air Quality Directives).

The Consultant will develop a design of the air quality monitoring network and recommendations for air quality management in Nepal including:

1. Number of monitoring stations, identifying key stations and indication of the location types in the network;
2. Pollutants to be measured;
3. Recommendations for the operation, calibration and maintenance of the instrumentation including the calibration laboratory;
4. Recommendations for chemical analysis laboratory;
5. Recommendations for air quality data management, reporting and data dissemination;
6. Priority lists and technical recommendations for needed investments for pilot air quality measurements and data management systems under the PPCR project;
7. Recommendations for the institutional organization, staff and training required for different parts of efficient air quality management;
8. Sustainability plan for the observation system

The requirements from the legislation and the local capacities for the operation of the network and laboratories will be taken into account in the recommendations for the number of monitoring stations, pollutants to be measured and calibration and chemical laboratory. In addition the emissions affecting the air quality will be considered when identifying the number and locations of the monitoring stations and the pollutants to be measured. Priority lists and technical recommendations for the investments will be developed based on the legislative and technical requirements for air quality monitoring and data management taking into account the availability of financial and human resources.

The Consultant will develop the conceptual design of the air quality monitoring network in Nepal and the recommendations for efficient air quality management based on the information gained from the Client, knowledge of best international practices and experiences from other countries as well as available technical solutions and resources for air quality management.

The Consultant will design air quality monitoring network in Nepal and recommend efficient air quality management based on information gained from the Client, knowledge of best international practices and experiences from other countries as well as available technical solutions and resources available at national level.

The scope of consulting services also includes:

1. Review legislation and legal frameworks in the context of air quality monitoring and assessment;
2. Review of various existing air quality and emission standards, i.e. ambient air quality and industrial and vehicle emission standards etc.
3. Review specific capacity needs at DHM and assess the human resource capacity at a professional level;
4. Clarify linkages among Governmental and Non-Governmental environmental agencies (such as Ministry of Science, Technology and Environment, Department of Environment, department of environmental sciences or environmental engineering at academic institutions, I/NGOs working in environmental sectors etc.);
5. Analyse existing facilities (including facilities that could be used for outsourcing selected activities) and assess network;
6. Make initial plan for data acquisition, data management and data dissemination and recommendations how to integrate air quality data into DHM main hydrological and meteorological database system;
7. Conduct stakeholder interactions to evaluate the effectiveness of air quality monitoring system.

Initial design consideration for Air Quality Monitoring:

The design of the air quality monitoring network will be based on a conceptual design of a state monitoring network, estimating a range for the number of stations required and their approximate location. This will also include possible monitoring methods, with a view to the objectives, costs and available resources and sustainability. A typical approach to the conceptual network design involves placing monitoring stations at selected representative locations, chosen on the basis of required data and known emission/dispersion patterns of pollutants under study in order to create a cost effective air quality monitoring program. Carefully selected sites will generate more useful data for regulators and other decision makers. A well-designed network is a key component of any air quality control program as operation and maintenance of stations is expensive and it is therefore desirable to use as few stations as possible to meet monitoring goals. The design should also include an initial plan for operation, maintenance, and calibration of stations as well as for data management, reporting and data dissemination. This includes calibration and chemical laboratory requirements and the supporting human and financial resources for operation.

The basic approach to network design is to match the scale of the air pollution problem:

- If air pollution is of predominantly local origin – then the network should concentrate within the urban area to monitor nitrogen oxides NOx (NO2 and NO), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter smaller than 10 µm (PM10) and 2.5 µm (PM2.5), if needed also Total Suspended Particulates, and volatile organic compounds (VOC)
- The network should be able to monitor both seasonal variation and short term variation of pollutants
- If there is a significant regional contribution to pollution then more emphasis should be placed on monitoring ozone (O3) and particulate matter.
- Another factor is large-scale phenomena, such as winter or summer smog episodes or dust clouds (i.e. local impacts should be avoided), i.e. possible establishment of regional background monitoring stations
- Monitoring of hot spots, for example monitoring of air pollution of industry. Monitoring should also be conducted in locations involving processes with by-products such as heavy metals and polycyclic aromatic hydrocarbons (PAHs); along with an understanding of source attribution (e.g. how much is from industry, traffic, etc.)
- The needs assessment and design should consider also monitoring of Green House Gasses (GHGs) given their influence on climate, atmospheric warming and glacier melting

Monitoring objectives and current monitoring system:

Defining objectives, output and monitoring requirements influences the conceptual design of the network and optimizes resources used for monitoring. It will also ensure that the network is specially designed to optimize information on problems at hand. There may be different objectives for the development of the environmental monitoring and surveillance system. Normally, the system will have to provide online data and information transfer with a direct/automatic/on-line quality control of the collected data. Several monitors, sensors and data collection systems may be applied to make on-line data transfer and control possible.

The main objectives for the development of an air quality measurement and surveillance program should be cognizant of:

- Population exposure and health impact assessment;
- Identifying threats to natural ecosystems;
- Determining compliance with national or international standards;
- Informing the public about air quality and establishing alert systems;

- Providing objective input to environmental management and to transport, land-use and industrial planning;
- Identifying and apportioning sources;
- Developing policies, strategies, standards and setting priorities for clean air action plans;
- Developing and validating tools such as models and GIS;
- Quantifying trends to identify future problems or progress in achieving targets.

For the purposes of this study - a questionnaire will be developed for the Ministry of Science, Technology and Environment (MoSTE), Department of Environment (DoEnv) and DHM in order to obtain information on the objectives, institutional set-up and operational and maintenance costs of the current monitoring system in Nepal. The questionnaire will also include a section on emissions including the major sources of available (e.g. type of industry, process technology, production capacity, location of installation relative to population (on a map), possible emission reduction technologies in use, as well as annual emissions and discharges).

MoSTE, DoEnv and DHM will also facilitate obtaining further information on the density of the current monitoring network; type of monitoring systems, frequency of sampling and reporting; parameters measured; meteorological systems in place, data available to decentralized and central levels of government; and reporting requirements for different governmental institutions and the public. The Ministry will also attempt to provide information on the outcomes of key parameters measured, meteorological data over the past three years and the key sources of pollution (e.g. heat/energy production, traffic, etc.) which contribute to pollution. Population information will also be collected along with information on energy/heat production and traffic.

Density and geographical spread of monitoring stations:

Air Quality Monitoring areas are generally divided into the following groups considering also the ecological zonation and topographical variation of Nepal:

- Urban including traffic, residential and background
- Suburban (traffic and industrial)
- Rural sites (background areas)

Monitoring results provide a sum of impacts or contributions originating from different sources on different scales, for example:

- Natural background concentration
- Regional background

- City average background concentration
- Local impact from traffic along streets and roads
- Local impacts from small area sources like open air burning (waste and cooking)
- Impact from large point sources such as emissions and discharges from industrial emissions, brick kilns and power plants

The conceptual design will take into account such representation of different impacts. For this, meteorological data will be required and an identification and quantification of sources contributing to the impacts and measurements,

The study will analyze typical air sheds present in Nepal, key industrial pollution sources and population centers as well as the meteorological information in order to provide a map of key impact areas and a range of the density and proposed geographical spread of required monitoring and meteorological stations to support a more modern air monitoring network in Nepal.

Air quality parameters and available technologies

Air quality parameters to be monitored will be defined for different environmental issues and challenges. Several environmental issues to be addressed are: climate change, influence on the Himalayan glaciers, ozone layer depletion, topographical variation, acidification, toxic contamination, urban air quality, microclimatic variation within an urban areas, traffic air pollution and industrial air pollution

The most commonly selected air quality indicators for urban and industrial air pollution are: Nitrogen oxides (NO_2 and NO), Sulfur dioxide (SO_2), Carbon monoxide (CO), Particles with aerodynamic diameter less than 10 µm and 2.5 µm (PM10 and PM2.5), Ozone (O_3), Volatile organic compounds (VOC) and Heavy metals, PAHs and in some cases sulfur and nitrogen deposition, Total Suspended Particulates and Black Carbon (BC).

The US EPA refers to the first five compounds listed above as priority pollutants. They are also listed in the Air Quality Daughter Directives of the European Union with specific limit values for the protection of health and the environment. The World Health Organization guideline values also include the above indicators. The study and monitoring network design will include a list of parameters to monitor, and locations.

The study will also provide information on different types of technologies available for monitoring and provide a comparison based on their advantages and disadvantages in terms of cost, available suppliers and operation and maintenance requirements including quality assurance and reporting.

Institutional Analysis:

The study will also analyze the supporting institutional requirements for data handling, storage, quality assurance, reporting procedures and public access to information. The data provider typically has the responsibility for documentation to support credible data collection, including procedures of data collection, application of calibration factors, Quality Assurance procedures (QA/QC), data analysis, data “flagging”, averaging and reporting. The study will analyze the current institutional set-up, effectiveness regarding these items and provide recommendations on system improvements. Capacity building recommendations will also include the need for personnel for different tasks, training needs regarding operation of the monitoring network, maintenance and calibration of instrumentation, data management, validation, analyses, reporting and possible operation of the chemical laboratory.

7. Guidance, Supervision and Quality Assurance

Project Management Units (PMUs) have been established in each of the two implementing agencies (DHM and MoAD), and include technical, financial, procurement, environment, social, monitoring and evaluation specialists.

General consultant/system integrator (SI) is hired for four years to provide service to DHM. The main objective of SI is the development of technical documentation for the implementation of each of the project component and effective technical support for project activities in order to achieve project goals.

All key outputs/deliverables including designs and reports will be subjected to review at various levels. On technical matters, the consulting firm will work in close consultation with NPD, PMU, SI and Project stakeholders.

The consulting firm can get technical support and guidance from SI as and when required during the period of implementation. In addition the Consulting firm will hold:

- Regular (monthly) consultations with DHM
- Kick off meeting with key stakeholders (including sector representatives)
- Time to time updates with key stakeholders (including sectors representatives)
- Basin level and field level consultations with local level GOs/NGOs and community representatives ensuring GESI.

8. Client’s Commitments (Inputs)

Staff of DHM/PMU will provide basic organizational support to the Consultant.

At the request of the Consultant, DHM should provide following documents.

- Information and data related to the project including information on status of observation networks, monitoring/lab equipment, communication, computing resources, and data processing tools;

- Information on the density of the current air quality monitoring network; type of monitoring systems; responsible agencies tasked with monitoring (and what they monitor); frequency of sampling and reporting; parameters measured; meteorological systems in place; and data available to central and decentralized levels of government as well as reporting requirements for different governmental institutions and the public;
- Data on key air quality parameters measured and meteorological data over the past three years; key sources of pollution; and the earlier sampling sites
- Project Appraisal Document (PAD), reports of missions and other relevant publications;
- Administrative, financial, legal and regulatory documents in support of activities; and
- Consultant's staff may work in environmental monitoring stations and, if necessary, in any other location in Kathmandu, as per necessity of coordination in relation to the services.

9. General Requirements of the consultant/Service provider

The Consultant should have at least 10 years of international working experience in designing, establishing and operating air quality monitoring systems and networks. Experience in designing and establishing such networks in developing country contexts as well as experience in Asia and Nepal in particular will have advantage. The service provider should have demonstrated experience in capacity building of local staff charged with operating and maintaining air quality monitoring systems. Market knowledge of available technology and monitoring equipment (i.e. advantages, disadvantages, limitations, cost considerations, etc.) and knowledge of international best practices, standards and guidelines are essential. In addition, the Consultant should also have experience with hydromet observations and service delivery and integrating environmental monitoring into hydro-meteorological monitoring systems. The staffing requirements of key personnel for this assignment will include a minimum of the following positions.

9.1 International

1. Team Leader (TL)/Air Quality Monitoring Expert (3 Month):

The Team Leader (TL) will have at least 10-years of experience in planning, designing and managing air quality monitoring systems relevant to this assignment. TL will play a role of a coordinator and has major responsibility in the implementation arrangements of the consultancy. TL is responsible for an overall management including quality assurance, and timely delivery of outputs and reports. S/he will transfer the knowledge on international best practices in air quality monitoring to DHM personnel's and the concerned departments through training workshops and seminars in atmospheric chemistry, modern observation technology and international air quality legislation. The team leader should spend 2 months' time in Nepal.

Qualifications:

- Master's degree in Environmental Science/Environmental Engineering/ Chemistry/ Meteorology/ Engineering or any related discipline. Relevant PhD degree will be an advantage.
- Minimum ten years' experience in designing and operation of air quality monitoring networks. Working experience in developing country physiographic particularly in south –Asian region and socio-economic conditions will be an advantage. Proven experience in successful design, development, and management of projects (including financial management) ensuring alignment with requirements of concerned institutions and development partners.
- Working knowledge of needs assessments, atmospheric processes, meteorology.
- Working knowledge of appropriate technologies required for air quality monitoring.
- Working knowledge in Human Resources Development
- Strong command in computer application and communication.

2. Environmental Chemist/Air Chemistry expert (0.5 Months)

The expert will have expertise in monitoring air quality monitoring, environmental chemistry integrating with meteorological monitoring system. The expert will support the TL in the needs assessment and design for air quality monitoring network and draft specifications for pilot monitoring. S/he will have major responsibility in assessment and plan of the air quality laboratories.

Qualification:

- Minimum M. Sc. in Environmental Chemistry or other related discipline.
- More than five years of international experience in designing and operating air chemistry laboratories. Experience in developing country as well as experience in Asia and Nepal in particular will have advantage.
- Market knowledge of technological and market options for air chemistry laboratory equipment (i.e. advantages, disadvantages, limitations, cost considerations, etc.)
- Knowledge of international best practices in air quality monitoring and international air quality standards and guidelines

9.2 National Experts:

1. Environmental Monitoring Expert/Deputy Team Leader (3 Months)

The expert will support the team leader in making the need assessment and design of air quality monitoring systems and in overall management of the project. S/he will be mainly responsible for carrying out the needed field assessments and site surveys. The expert will also support the international experts in collecting necessary background information and carrying out the assessments and in transfer of knowledge to DHM personnel through training workshops and seminars in air chemistry, observation systems, environmental assessment, data management and environmental legislation.

Qualification:

- Minimum Master's degree in Environmental Sciences/Environmental Engineering /meteorology or a related discipline.
- Minimum two years' experience in managing similar type of projects
- The expert will have at least 5 years' experience in air quality monitoring
- S/he will have proven knowledge to conduct the training on environmental monitoring, environmental assessment, computer applications, data processing and database management.

10. Time Schedule and deliverables

S. No.	Tasks	Timeline (from the date of contract signing)	Deliverables
1	Inception Report	2 Weeks	Report
2	Preparation of draft informational questionnaire for MoSTE, DoEnv and DHM	3 weeks	Questionnaire
3	Needs assessment of air quality monitoring in Nepal	2 month	Report
4	Design of air quality monitoring system and pilot measurements stations in Nepal	3 months	Report
5	Interim progress report	3 months	Report
5	Specifications and tender documents for pilot air quality monitoring stations under the PPCR project	4 months	Report
6	Report on operation and sustainability of the system	4 months	Report
7	Final report	5 months	Report

11. Reporting

Reporting requirements shall be as follows: All the reports are to be submitted with 3 hard copies along with e-copies

Report No.1 - Inception Report

The consultant shall submit an Inception Report within 2 weeks from the date of signing the contract. The report will be based on elaborate discussions with DHM, MoSTE, DoEnv, WECS, GOs, I/NGOs, CBOs and other stakeholders. The consultant shall review and verify the content of the tasks and methodologies required. Specifically, the consultant shall review the existing information, identify gaps and make specifications of the surveys necessary for filling information gaps. The consultant will also elaborate on: (i) additional tasks, (ii) work and staffing plans, and (iii) reporting modalities. The report must also clearly specify all risks and issues, which may negatively affect project deadlines and effective execution of project activities.

Report No.5 - Interim (Progress) Report

The consultant will submit an interim progress report within 3 months. It will include among others tasks related to reports 1-4, Workshops/consultation with experts, stakeholders including GOs, I/NGOs and civil society.

Report No.7 Final Report

Final Report (within 5 months)

12. Payment Schedule

10 percent on signing of contract as advance against a bank guarantee;

40 percent after submission and approval of Interim Progress Report;

40 percent after submission and approval of Draft Final Report;

20 percent after 6 months of the acceptance of Final Report.

13. Selection Procedure and Form of Contract

The consultant shall be selected on the basis of Consultant's Qualification Selection (CQS) method and consistent with the World Bank's Consultant Selection Guideline, 2011, and on the basis of required qualifications and related experiences. .

14. Duration of assignment

5 months