Government of the People's Republic of Bangladesh
Ministry of Water Resources

Water Resources Planning Organization

Terms of Reference (ToR)
for

বাংলাদেশের উত্তর-পশ্চিম হাইড্রোলজিক্যাল অঞ্চলের ১৩ টি জেলায় অ্যাকুইফার ম্যাপিং প্রণয়ন এবং পানি সংকটাপন্ন এলাকা নিরুপন

(Aquifer Mapping Preparation and Water Stress Area Assessment in 13 Districts of the North-West Hydrological Regions of Bangladesh)

Component 2:
"Hydrogeological Investigation and Modelling"

February, 2026

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1. Introduction:

Sustainable solutions to water problems require a paradigm shift from compartmental sub-sector-wise development to holistic water governance. Such a paradigm is encapsulated in the Integrated Water Resources Management (IWRM) concept. IWRM challenges conventional, fractional water development and management systems and emphasizes an integrated approach with coordinated decision making across sectors and scales. Furthermore, to face the growing challenges regarding water rights, protection of resources, water use, and water services management, Bangladesh has enacted a comprehensive legal framework called the Bangladesh Water Act, 2013, which received the President's assent on 2nd May 2013. This act outlines a coordinated and comprehensive regime for the development, management, extraction, allocation, use and conservation of water resources.

Therefore, it is necessary to put the Bangladesh Water Act, 2013 and the Bangladesh Water Rules, 2018 into practice in the entire Bangladesh and to understand local economic and social dynamics related to water management in line with IWRM concept. At a local scale, the problems of water scarcity in the critical and vulnerable areas in Bangladesh continue unchecked, existing irrigation and drinking water wells are being abandoned or operate at reduced capacity, the water table continues to fall unsustainably. Awareness of the problems, inside and outside the critical areas, has increased but initiatives to reverse the trends have been piecemeal, uncoordinated and inadequate in scale. Several projects took important steps to correct the problems, but much more is needed to coordinate, implement and facilitate water-saving and water-enhancing actions.

Water Resources Planning Organization (WARPO) is an apex organization under the Ministry of Water Resources (MoWR), dealing with nationwide water resources planning and is designated by the Bangladesh Water Act, 2013 as the nodal agency for coordinating IWRM. WARPO is mandated as the lead agency for implementation of the Act and its Rules and the regulation of water resources development. The National Water Policy (NWPo), 1999 also requires that WARPO will routinely update the water resources assessment of the country and monitor the state of water resources system so that the implementation, performance and the impacts of the National Water Management Plan (NWMP)/the National Water Resources Plan (NWRP) can adequately be addressed. Thus WARPO will implement the proposed project in compliance with the Bangladesh Water Act, 2013 and Bangladesh Water Rules, 2018 to protect the water sources and aquifers, and to develop sustainable water resources management in solving practical problems of water scarcity.

The problems of water resources in most of the districts of Bangladesh are enormous. This study has been undertaken in 13 districts in the North-West hydrological regions of Bangladesh where complex hydrogeological conditions make water supply difficult. In spite of having large number of natural streams, ponds and decent groundwater storage, the scarcity of potable water is acute. Groundwater of acceptable quality is not available in most

parts of these regions due to relatively shallow depths for easy withdrawal by conventional hand pump tube wells which has caused significant negative impacts on agricultural, fish and livestock production. Other problems include drainage congestion, flooding, erosion and sedimentation in rivers etc. The use of easily available waters as source of domestic water supply requires extensive costly treatment which is not a practical proposition for scattered rural population nor affordable in the context of rural economic condition in the study area.

Bangladesh, being an agricultural country, is highly dependent on groundwater irrigation given the fact that the existence of this resource was seen as abundant till recent years. As the surface water supply is decreasing day by day during the dry season, but the demand for irrigation is ever increasing, so the increasing trend in agricultural production is leaving the aquifer in vulnerable brink. Groundwater irrigation drastically increased in Bangladesh since the last three decades. But the source is limited and it is declining day by day due to intensive use of tube wells during dry season. In addition, rapid urbanization and industrialization in the recent years make the situation more critical. According to Bangladesh Water Act, 2013 and its Rules, it is important to identify the water scarce areas and sustainable water resources management. The paradigm shift from 'groundwater development' to 'groundwater management' in Bangladesh as laid out in Bangladesh Water Rules, 2018 through aquifer mapping in different hydro-geological settings require robust groundwater management plans at the appropriate scale to be devised and implemented. As one of the major sources of water for the country as well as an inevitable part of the hydrological system, groundwater resource needs to be seen as limited resource and therefore its management plan should associate the specification of sustainable abstraction limit.

The recent downward trend in groundwater levels in most of the districts of Bangladesh is evidently representing the alarm, coined with the rapid urbanization and industrialization which is persistently decreasing the potential recharge area as well as deteriorating quality of water. The groundwater aquifer is in complex nature, mainly addressed by deep. The scope for groundwater recharge has been reduced drastically due to unplanned paving in most of the areas. On the other hand demand is increasing day by day. As a result, groundwater table in these districts is successively falling by years with increasing withdrawal of water for domestic, municipal, industrial and irrigation. Therefore, it is very important to assess the quantity and quality of surface and groundwater resources and their use and demand in the study area. Assessment of surface and groundwater resources in these districts (13 nos) of North-West region within the proposed project will help to address the efficient use of surface and groundwater resources as well as sustainable water resources planning and management for operationalizing the Bangladesh Water Act, 2013 in Bangladesh. To undertake this assessment, services will be required of qualified professional firms/organizations experienced in hydrological investigation and modelling of the state of surface water and ground water resources in the project area.

A detail analysis and modelling through a proven scientific tool will be required to enable the user to analyze and set the threshold limits for abstraction and usage considering future climate change and sustainability and for the enforcement to operationalize the Bangladesh Water Act, 2013 and its Rules. Numerous studies are conducted on groundwater depth fluctuation, recharge potentials and aquifer characteristics for the different regions on a broader scale revealing the vulnerability of the aquifer and groundwater resources. However, actual representation of the aquifer system and water budget based on hydrodynamic modelling is required to examine the present and future vulnerability scale. The Bangladesh Water Act, 2013 keeps the provision of determining the safe yield level of aquifer, and declaration of Water Stress Area for a specific period, which seeks a clear understanding of the state of water resources of the designated area to have proper monitoring of the implementation of the Bangladesh Water Rules, 2018.

Assessment and management of water resources could be done considering surface water and groundwater in isolation but this isolated approach would fail to address the integrated behavior of the land and water ecosystem, interaction between the surface and groundwater within the water ecosystem as well as water environment. To ensure the integrated management of resource base, a physically based distributed modelling system would be more realistic and appropriate over the traditional analytical approach. Mathematical model enables better understanding of the river-aquifer interaction, as well as, providing a tool that can be used to manage the water resources in the best possible way considering the relative contribution of the components on the water balance in the study area. The best option of future surface water and groundwater developments which will effectively utilize all available water resources with no or minimum negative environmental impacts is possible to find out through application of the surface water and groundwater interaction modelling technique. Therefore to ensure integrated management of water resources a physically based distributed modelling system would be more appropriate and realistic.

2. Project area

The Project will promote and facilitate the operationalizing of the Bangladesh Water Act, 2013 and the Bangladesh Water Rules, 2018. Most of the activities will be targeted at implementation of the Act and its Rules, IWRM interventions and assessment of state of water resources in the administrative limits of 13 districts in the North-West hydrological regions of Bangladesh (Fig. 1 An active water management area will be precisely aligned during the Inception period to coincide with Mouza boundaries.

The total task of Hydrogeological Investigation & Modelling will be conducted through 01 (one) package. Table 1 shows the district names for this hydrological regions.

Table 1: Project Area (13 Districts) within North-West Hydrological region

Sr. No.	Name of Division	Nos. & Names of District	Nos. of Upazilla	Nos. of Union	Nos. of Mouza
1.	Rajshahi	**5** (Bogra, Joypurhat, Natore, Pabna & Sirajganj)	42	348	6,536
2.	Rangpur	**8** (Rangpur, Dinajpur, Gaibandha, Lalmonirhat, Kurigram, Nilphamari, Thakurgaon & Panchagarh)	58	535	6,703
Total		**13**	**100**	**883**	**13,239**

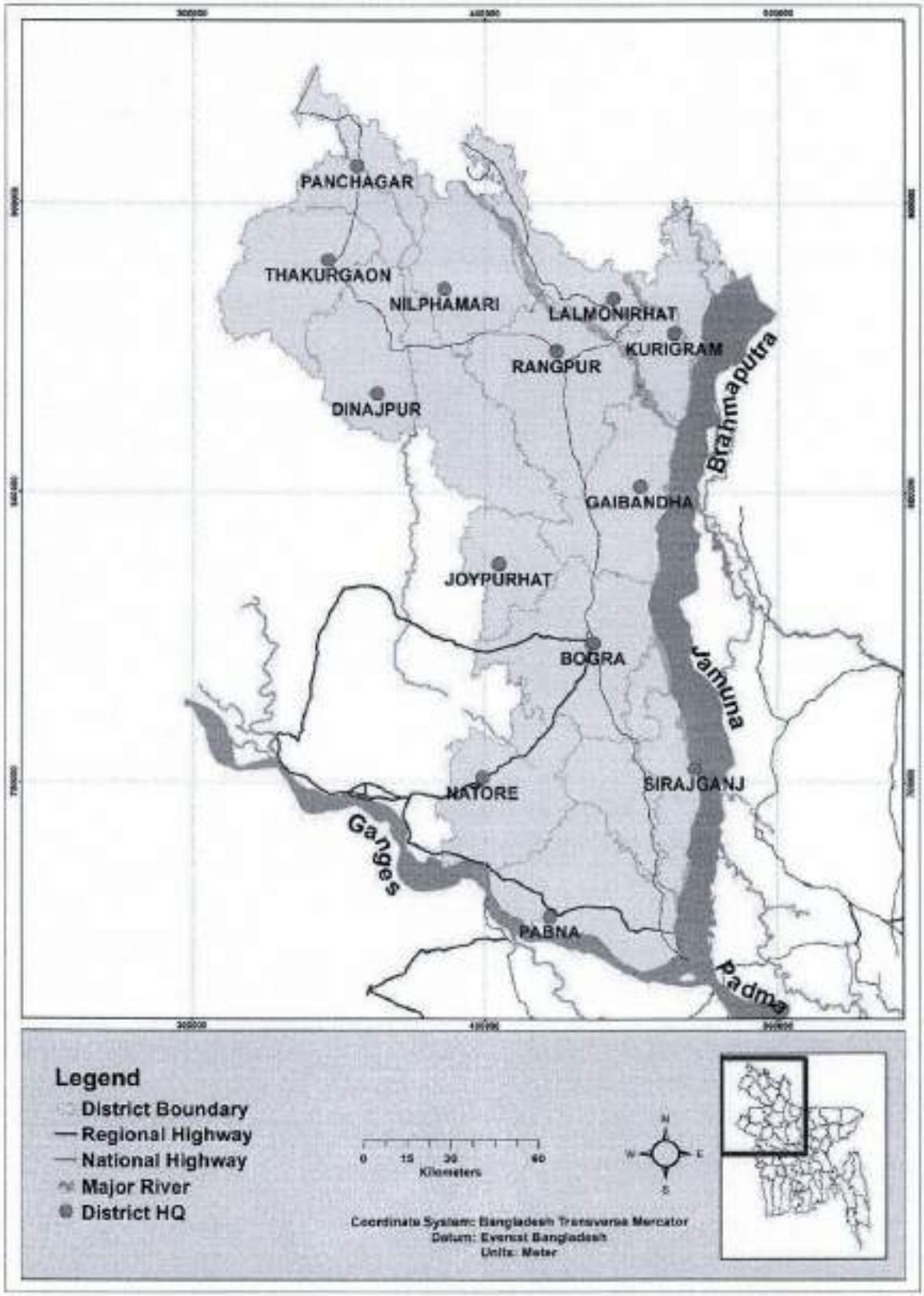

Fig. 1: Project area (13 Districts) within North-West hydrological region of Bangladesh

3. Objectives

The main objective of this component is to assess the water availability and water quality of surface and groundwater resources, prepare aquifer mapping, determine the safe yield level of the aquifer and identify the Water Stress Area (WSA) in the 13 districts of the North-West hydrological regions of Bangladesh for supporting operationalization of the Bangladesh Water Act, 2013 and Bangladesh Water Rules, 2018.

The specific objectives of this study are -

(i) to investigate and provide necessary comprehensive data, map and information of the surface water and groundwater availability, quality and aquifer mapping of the study area;

(ii) to determine the safe yield level of aquifer up to union/mouza level and evaluate the trend of groundwater movement based on the recharge potential of the study area;

(iii) to determine Water Stress Area (WSA) considering present and future availability, use, demand and quality of surface water and groundwater resources in the study area;

(iv) to develop and disseminate appropriate strategies for conjunctive use of rainwater, surface water and groundwater to improve efficiency of resource utilization and minimum groundwater abstraction; and

(v) to establish a modern ICT-based Decision Support System (DSS) at WARPO using machine learning technology.

4. Scope of Works

The major scope of works of the Consultants for this study will be

(i) Collect hydrological, meteorological, hydro-geological, morphological data, Digital Elevation Model (DEM), groundwater level, water quality, aquifer properties and other necessary data from secondary sources as per required.

(ii) Conduct field cross section survey of the major rivers and their tributaries/ distributaries, install IoT sensors for measurement and monitoring water level & discharge and river bed material sampling and analysis.

(iii) Supervise exploratory drilling and installing necessary groundwater monitoring wells to fill up data gap, and put older wells back into service to study and monitor groundwater level, quality, aquifer system and subsurface lithology of the study area.

(iv) Carry out Geophysical Resistivity Survey (GPRS) through Vertical Electric Sounding (VES) study to formulate the composition and nature of the aquifer system in the study area.

(v) Perform pumping tests to investigate the hydraulic properties of the aquifer such as the specific storage, specific yield, porosity, transmissivity, hydraulic conductivity etc.

(vi) Develop an automated groundwater monitoring systemto provide real time data collection through installation of IoT sensor system, and instant transfer to the cloud-based server at WARPO.

(vii) Collection of water samples from river and aquifer, perform in-situ tests and laboratory tests to investigate surface water and groundwater quality through hydro-chemical analysis.

(viii) Prepare aquifer mapping with GIS datasets depicting aquifer extent, thickness and continuity, aquifer properties, geophysical parameters and water quality parameters.

(ix) Develop/update hydrodynamic model, water balance model and rainfall-runoff model, along with any additional models required for the study area.

(x) Develop a groundwater model and integrate it with existing surface water model to establish a coupled surface water-groundwater interaction model for comprehensive assessment of water resources.

(xi) Assess present and future surface water and groundwater availability, water quality conditions and recharge mechanism using the coupled surface water-groundwater interaction model.

(xii) Forecast water availability and sectoral water demand for the years 2030, 2040, and 2050 under projected climate change scenarios, socio-economic growth, and land-use change trends.

(xiii) Determine and fix the safe yield level of aquifer up to union/mouza level of the study area based on water resources availability, use and recharge potential.

(xiv) Determine and identify the Water Stress Area (WSA) considering present and future water availability and uses, water quality and recharge potential in the study area.

(xv) Develop and disseminate appropriate strategies for conjunctive use of rainwater, surface water and groundwater to improve efficiency of resource utilization and minimum groundwater abstraction.

(xvi) Establish a modern ICT-based Decision Support System (DSS) at WARPO using machine learning technology for data imputation and forecasting.

(xvii) Ensure smooth coordination with other vendors, including PRA, monitoring well and production well installation teams.

5. Expected Output

The outputs of the study are as follows:

1. Base map of the study area using updated information showing surface water and groundwater availability, uses, demand, groundwater level, aquifer properties, observation/ monitoring wells, alignments of rivers and canals, wetlands etc;
2. Maps and charts of surface water and groundwater quality regime showing distribution of important chemical constituents;
3. Aquifer mapping with GIS datasets showing aquifer geometry, aquifer properties, geophysical and water quality parameters.
4. An automated IoT sensor-based groundwater monitoring system linked to WARPO server.
5. A coupled surface water-groundwater interaction model for comprehensive assessment of surface water and groundwater resources in the study area;
6. Charts and map showing union/mouza-wise safe yield level of aquifer in the study area;
7. Water stress mapping at the mouza level in accordance with the Bangladesh Water Act, 2013 and the Bangladesh Water Rules, 2018.
8. Maps showing Water Stress Area (WSA) considering present and future water availability and uses, water quality and recharge potential in the study area; and
9. A modern ICT-based Decision Support System (DSS) at WARPO.

6. Data Collection and Methodology:

The approach of collecting required data on hydrological, meteorological, hydro-geological, morphological, cross section of the major rivers and their tributaries/distributaries, Digital Elevation Model (DEM), groundwater level, water quality, aquifer properties, lithological data, existing DTWs/STWs and monitoring wells, required field survey and investigation, pumping tests, laboratory tests are to be submitted by the Consultant before commencement of the study. The methodology to execute the mathematical modelling works and the Critical Path Method (CPM) analysis are also to be submitted by the Consultant.

7. Work Plan and Manning Schedule

The Work Plan and the manning schedules of the study for Modelling Personnel are to be submitted by the Consultant.

8. Duration of the Contract

The Consultant will be procured for a period of **26 (Twenty-Six) months** from the date of commencement according to the Contract.

9. Major Deliverables

(i) Detailed reports on present and future water resources availability, water use, sectoral water demand and water quality conditions in the study area.

(ii) Detailed reports on the aquifer system, groundwater level fluctuation, recharge potential and safe yield level of aquifer within the study area.

(iii) Detailed reports on Water Stress Area (WSA) based on present and projected water resource shortages considering current and future water uses in the study area.

(iv) Detailed report outlining appropriate strategies for conjunctive use of rainwater, surface water and groundwater resources.

(v) Detailed report on the Decision Support System (DSS) to be established at WARPO under this project, including its architecture, functionalities and operational guidelines.

(vi) DSS implementation, IoT installation and support services, maintenance, and groundwater data collection for two years after commissioning.

10. Professional Inputs

Formation of an effective team of professionals is prerequisite for the successful completion of any assignment. This is particularly important in a project like the proposed study with the stipulated objectives. A very careful thought has, therefore, been given in forming the team composition with a number of national professionals. Thus, the team members have been selected considering their academic qualification, professional expertise and practical experience of conducting similar studies as well as the requirements described in Terms of References (ToR) and the individual tasks proposed under each position of the project. The assignment of the Consultants will require substantial experience in their respective fields.

The Consultants will be engaged under a single contract acting as one team of experts. It is estimated that for carrying out the above-mentioned study including relevant data collection and modelling tasks, a total of **300 man-months** of consulting services will be required for the project. The estimated staff requirements for the study have been given below in the following table:

Sl. No.	Description of the Position	Nos, of Consultants	Input (man-month)
1	Senior Water Management Expert/Team Leader	1	20
2	Senior Water Management Specialist	1	16
3	Senior Hydrologist	1	16
4	Hydrodynamic Modeller	2	36
5	Groundwater Modeller	2	36
6	Hydrogeologist	4	48
7	GIS/RS Specialist	2	20
8	Database Management Specialist	1	12
9	Software Developer	2	24
10	Hydrochemist	1	12
11	Survey Specialist	1	12
12	Data Analyst	2	24
13	Field Coordinator	4	24
	Total	**24**	**300**

11. Qualification and Responsibilities of the Consultants

The educational qualification, required experiences and the tasks and responsibilities of each of the Consultants have been described in details in **Annexure - I**.

12. Survey & Data Collection and Automation of Monitoring Wells

The Consultants have to carry out the following activities for survey and data collection, installation of IoT sensors and automation of monitoring wells:

Survey, Investigation & Data Collection			
Sl. No.	**Description of Items**	**Unit**	**Quantity**
1	Data Collection (Available Hydrological, Meteorological, Hydro-geological etc) from secondary sources	LS	LS
2	Cross-section Survey of Rivers, Canals etc.	Nos.	1,000
3	River Bed Material Sampling and Analysis	Nos.	100
4	Geophysical Resistivity Survey through Vertical Electric Sounding (VES)	Nos.	100
5	BM/RL Connection of Monitoring Well	Nos.	350
6	Automation of GW Monitoring Well with IoT sensors	Nos.	350
7	Installation of Seepage & Percolation Measurement Pipe	Nos.	100
8	Measurement of Seepage & Percolation	Nos.	100

12.1 Technical Specification for Automation with IoT sensors:

Serial no	**Item**	**Specification Draft Final**	
1	Sensor	Probe materials	SS304 / 316L grade stainless steel, Titanium Optional, Polyamide
		Sensed Data	Groundwater level, Temperature and Pressure
		Sensor Method	Absolute Piezoresistive pressure sensor chip, encapsulated insulated
		Measuring Range	0-300m
		Protection Rating	IP68/1P69
		Analog interface	4-20 mA (2-wire) and 0…5 V, 0…10 V (3-wire)
		Digital interface	RS485/Modbus/SDI-12
		Calibration	Factory Calibrated
		Standard cable lengths	20~300m (as required)
		Accuracy	≤ ± 0,1 %FS
		Cable for water applications	4-core of Kavaler stringed PU insulation/ polyethylene (PE) ø 5,8 mm

Serial no	Item	Specification Draft Final	
		Operating Temperature	-20~85 °C
		Pressure Ranges	0…0,1 to 0…25 bar
		Total error band	≤ ± 0,25 %FS (0…50 °C)
		Communication protocol	Modbus RTU
		Vibration resistance	10 g, 10…2000 Hz, ± 10 mm
		Long-term stability	≤ ± 0,15 %FS
		Power supply	8…32 VDC (2-wire)/ 8…32 VDC & 13…32 VDC (3-wire)
		Lightning protection	10…32 VDC
		Overvoltage protection and reverse polarity	± 32 VDC
		Shock resistance	50 g, 6 ms
		Applications	Groundwater
		Certifications	CE-conformity as per 2014/30/EU (EN IEC) or Equivalent Certificates
2	Data Logger	Digital Interface	RS485 modified-MODBUS (Supports up to 128 transmitters on a single bus.)
		Tech Stack	Python/C++/Java/ any preferred stack
		Network (WAN)	4G/LTE-Cat-M1 and NB-IoT with 2G fallback (Global).
		SIM/Roaming	One (1) SIM, multi-network global roaming included in 180+ countries (nano SIM is preffered)
		Data Transmission/ Protocol	MQTT/Modbus/HTTP(S)/ Periodic, Scheduled, Event-driven dynamic IP profile. (Antenna: External mandatory).
		Primary Power	Internal LiSOCl2 battery, 3.9 VDC 3 A, non-rechargeable, 32 Ah capacity.
		External Power	6–24 VDC input with automatic source switching.
		Operational Run Time	At least 5 Years
		Sensor Ports	Supports up to 4 sensors. Port #1 includes: 2× Analog Input, 2× Digital Input/Pulse Counting/Output.
		Analog Input Range	0–33 mA and 0–27.5 V (universal inputs).
		Analog Accuracy	Max ±0.9% (Voltage) / ±0.5% (Current)
		Data Storage	At least 1 million samples or >=8GB; 10 years of water level data storage

Serial no	Item	Specification Draft Final	
		Display	LCD, OLED showing network strength, sensed data. Sleeps automatically while unused
		Data Security	TLS 1.3, AES-256 encryption. Secured Pairing Key.
		Time Sync	NTP server (cloud or on-prem)/RTC Clock
		Configuration	Remotely through Mobile App connected with Bluetooth/ Computer/Laptop
		Offline Data Retrieval	Yes, Through Mobile/ Computer App
		Server Connection	Will be able to connect any web/ftp server to transmit sensed data
		Integration/ Output File Format	REST API, CSV, JSON and or SCADA
		Rating	IP68/IP69, NEMA 6P (Water- and Dust-proof).
		Operating Temp	-20–85 °C
		Humidity	30–95%, with condensation.
		Platform	On-prem and Web-based UI.
		Warranty	2-year warranty (Time will be calculated from office deployment and commissioning)
		Certifications	CE, NSF/ANSI, EN Certificates or Equivalent Certificates

* Special Criteria to be fulfilled:

1. Devices must withstand any natural and man-made conditions. So, the device and device housing must be weather-proof, electrical surge proof and robust.
2. The devices should consume minimal power to ensure long-lasting battery life.
3. The batteries shall have a minimum lifespan of five (5) years. During this period, any damage or malfunction shall be repaired free of cost.
4. The Device must have internet connectivity through established mobile network companies of Bangladesh to push ground water level data periodically to our server. Server information and time period should be configurable.
5. The Logged ground water data can be visualized from the central dashboard. The dashboard must provide proper analytics and comparative visualization from the logged data with various time periods.

6. The Service Level Agreement (SLA) shall remain valid for a period of two (2) years from the date of successful commissioning and acceptance of the groundwater level automation device by the Water Resources Planning Organization (WARPO). During this period, the vendor shall be responsible for maintenance, ensuring smooth data collection, and bearing all costs related to replacement or damage.

13. Field & Laboratory Tests

The Consultants have to carry out the following field and laboratory tests:

Field & Laboratory Test			
Sl. No.	**Description of Items**	**Unit**	**Quantity**
1	Pumping/Aquifer Test	Nos.	60
2	Hydrogeochemical investigations and laboratory tests	Nos.	250

14. Reporting Requirements

The following major Reports must be submitted after completion of the Modelling study:

(vii) Detail reports on water resources availability, water use, sectoral water demand, water quality in the study area.

(viii) Detail reports on aquifer system, groundwater fluctuation, recharge potential and safe yield level of aquifer in the study area.

(ix) Detail reports on Water Stress Area (WSA) under shortage of water resources considering present and future water uses in the study area.

(x) Detail report on appropriate strategies for conjunctive use of rainwater, surface water and groundwater resources.

(xi) Detail report on the Decision Support System (DSS) that will established at WARPO within this project.

In addition to the above Reports, the following reports need to be submitted time to time:

Sl. No.	Report	Deadline	Copies
1.	Inception Report	end of the 3rd Month	15 Copies
2.	Progress Report (2 nos.)	end of the 12th & 24th Month	10 Copies (each)
3.	Mid Term Report	end of the 15th Month	20 Copies

4.	Draft Final Report	end of the 27th Month	20 Copies
5.	Final Report	end of the 29th Month	25 Copies

15. Mode of Payments

All payment of the Consultants will be made through satisfactory completion of the work. All the reports must be approved by the Director General of WARPO before making any of the above payment. As per government rules, VAT and IT will be deducted from all of the payments to the Consultant. The consultant will get the payment as per the following schedule:

Invoice/ Bill No	% of Contract Amount	Against Deliverables
1st Invoice	20%	On submission of Inception Report
2nd Invoice	30% *(including 15% for IoT installation)*	On submission of the Mid-Term Report and installation of 120 IoT devices
3rd Invoice	30% *(including 20% for IoT installation)*	On submission of the Draft Final Report and installation of 180 IoT devices
4th Invoice	20% *(including 10% for IoT installation)*	On submission of the Final Report and installation of the remaining 60 IoT devices, including testing and commissioning

16. Duties and Responsibilities

16.1 WARPO's Responsibilities

The Project Director (PD) will ensure that the objectives of the study as detailed in the Terms of References (ToR) are achieved within the agreed time schedule. The Project Director will in the context of the ToR direct the study process and supervise the execution of the study and monitor progress according to the said objectives. In particular, the Project Director will take necessary action in good time where such monitoring shows that outputs are not likely to be supplied at the required time. The Deputy Project Director and the specialised professionals of WARPO shall assist the project team as required for the study. The Consultants will be required to reschedule activities by taking consent from the Project Director if this becomes necessary.

The Project Director and the Deputy Project Director will ensure that the Consultants will have regular meetings with them to discuss technical and project management issues. Any unresolved issue should be taken up with the Director General, WARPO for appropriate

solution. The Consultants will also report to Director General, WARPO regarding institutional strengthening support and other matters requiring specific guidance.

WARPO will be responsible for arranging the following facilities:

- All hydrological, hydro-geological, meteorological data from National Water Resources Database (NWRD) free of cost.
- Satellite images and previous reports available with WARPO.
- Provide assistance for arranging collection of data from other agencies, if needed.
- Make available information from other study components.

16.2 Consultant's Responsibilities

The Consultants shall work under the direct supervision of the Project Director (PD) of WARPO. The Consultants shall carry out the services as detailed in the "Scope of Works" and "Responsibilities of the Consultants" in the best interest of the study with reasonable care, skill and diligence with sound engineering, administrative and financial practices and shall be responsible to the executing agency (WARPO) for discharge of responsibilities. The Team Leader will be responsible to the Director General, WARPO for proper and timely execution of all the activities of the study mentioned in the ToR of the project.

The Consultants will be responsible for arranging the following facilities:

- Make necessary arrangements for site investigations and data collection as required for the study.
- Discussion with WARPO to avoid any duplication in the data collection.
- Handing over the collected data (primary and secondary) and study results to WARPO for their use and NWRD records.
- Making necessary arrangements for additional hydrological, meteorological, spatial, temporal, satellite images (GIS & remote sensing) and other necessary data collection from secondary source as needed for the study.
- Bearing the cost of data procurement and maps from BWDB, BADC, BMDA, DPHE and others at Government rate.
- Carrying out activities as per scope of work and delivering the study report.
- Handing over the procured goods and equipment to WARPO after completion of the contract.
- Providing support staff including administrative and financial staff needed for the effective delivery of the services.
- Arranging both theoretical and on the job training for WARPO professionals on mathematical modelling as a matter of technology transfer.

Annexure – I

Qualification, Experience and Responsibilities of Consultants
'Hydrogeological Investigation and Modelling'

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Senior Groundwater Management Expert/ Team Leader	01	He/she must have a Bachelor's degree, preferably with a Master's degree, in Civil Engineering/Water Resources Engineering/ Water Resources Management/Hydrology from a well reputed university.	He/she must have minimum 25 years of working experience in water resources planning and management having background in mathematical modelling in water resources sector. He/she must have minimum 15 years of practical working experience in leading similar projects on water resources management and groundwater modelling & assessment and leading multi-disciplinary and multi-national teams in similar water resources management projects. Working as Team Leader for similar projects will get preference.	▪ Overall responsibility for hydrological investigation and modelling task of the project. ▪ Full responsibility for all aspects of planning, liaison and reporting for the modelling team. ▪ Supervise all aspects of project implementation and work in close cooperation with Project Director. ▪ Study and review of previous water resources development projects in the study area. ▪ Examine present water availability and use scenario and water demand in the study area. ▪ Identify data gaps, bottlenecks and suggest primary data collection, if required. ▪ Develop approach and methodology for data processing, analysis and modelling. ▪ Orient the conceptual model and strategic work plan to carry out the modelling activities. ▪ Coordinate and supervise the modelling and investigation tasks of other experts in the team. ▪ Prepare the final report on aquifer mapping and hydrogeological modelling activities. ▪ Maintain close contact with the Project Director for regular reporting of project activities.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Senior Water Management Specialist	01	He/she must have a Bachelor's degree, preferably with a Master's degree, in Civil Engineering/Water Resources Engineering/ Water Resources Management/Hydrology/ Hydro-informatics from a well reputed university.	He/she must have minimum 20 years of working experience in water resources planning and management having background in mathematical modelling in water resources sector. He/she must have minimum 10 years of practical working experience in similar projects on water resources management and hydrodynamic modelling and groundwater modelling and assessment.	▪ Provide overall technical advice and support for planning, design and implementation of hydrological investigation and modelling tasks. ▪ Study and review of previous water resources development projects in the study area. ▪ Review and examine information related to water availability, use, quality and current and future sectoral demands. ▪ Identify gaps that need to be addressed to complete the surface water & groundwater assessment. ▪ Formulate and guide field survey in conducting aquifer test or pumping test. ▪ Identify groundwater recharge mechanisms, abstraction and demand for major aquifer systems. ▪ Determine and fix the lowest groundwater safe yield level for respective aquifer systems. ▪ Assist the Team Leader in preparing the details groundwater assessment report. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing the output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Senior Hydrologist	01	He/she must have a Bachelor's degree, preferably with a Master's degree, in Civil Engineering/Water Resources Engineering/ Water Resources Management/Hydrology from a well reputed university.	He/she must have minimum 20 years of working experience in water resources management and hydrological analysis in water resources sector. He/she must have minimum 10 years of practical working experience in similar projects on water management, surface water modelling, hydrological analysis and flood risk management.	▪ Study and review of previous water resources development projects in the study area. ▪ Review of surface water flows, static water resources availability, water use and demand in the study area. ▪ Process and analyze the hydrological data for water resources planning and flood management. ▪ Assess the relationship between rainfall, runoff, streamflow, evapotranspiration and soil water content. ▪ Undertake hydrological assessment to develop flood and drought management strategy. ▪ Develop rating curve for dry period. ▪ Estimate water yields, taking into account the utilization of surface water. ▪ Identify the potential water bodies for conservation as a source of potable water and aquatic habitat. ▪ Provide training to WARPO professionals on hydrological modelling. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Hydrodynamic Modeller	02	He/she must have a Bachelor's degree, preferably with a Master's degree, in Civil Engineering/Water Resources Engineering/ Computer Science & Engineering/Hydro-informatics from a well reputed university.	He/she must have minimum 15 years of working experience in surface water modelling, 2D and 3D hydrodynamic modelling, numerical model coding and post-processing. He/she must have practical working experience in similar projects with organizing large hydrological datasets, data assimilation techniques, pre-processing input datasets and post-processing model outputs, with excellent programming ability.	▪ Develop/Update the HD model for river flow assessment, rainfall-runoff model and any other model, if necessary, for the study area. ▪ Process and analyze the primary and secondary hydrological data for model set up. ▪ Develop and calibrate Water Balance model and specify boundary conditions. ▪ Assess the hydrographic conditions and hydrodynamics of rivers, lakes and reservoirs in the study area. ▪ Develop approach and methodology for decision making on regulation on different usages of surface water. ▪ Provide training on hydrodynamic modelling. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Groundwater Modeller	02	He/she must have a Bachelor's degree, preferably with a Master's degree, in Civil Engineering/Water Resources Engineering/ Hydro-informatics/ Groundwater Modelling/ Geology from a well reputed university.	He/she must have minimum 15 years of working experience in developing groundwater flow models, integrated surface water and groundwater interaction models, numerical model coding and post-processing. He/she must have practical working experience in similar projects with organizing large hydro-geological datasets, data assimilation techniques, pre-processing input datasets and post-processing model outputs, with excellent programming ability.	▪ Develop the Conceptual model to formulate the composition and nature of the aquifer system. ▪ Assist in collection, processing and analysis of all types of groundwater and aquifer related data. ▪ Formulate and guide field survey in conducting aquifer test or pumping test. ▪ Process and analyze the primary and secondary hydrological data for model set up. ▪ Develop and calibrate groundwater model from information relating to geological structure and aquifer properties. ▪ Simulate groundwater flow in aquifers including groundwater abstractions and interactions with river and other surface water bodies. ▪ Simulate groundwater levels and river flows for various scenarios such as changes in pumping rates, climate change scenarios. ▪ Carry out analysis of the groundwater recharge using groundwater models. ▪ Determine and fix the lowest safe yield level of aquifer in the study area. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Hydro-geologist	04	He/she must have a Bachelor's degree, preferably with a Master's degree, in Geology/Soil Science/ Hydrogeology/ Environmental Science or any other relevant field from a well reputed university.	He/she must have minimum 10 years of working experience in groundwater occurrence and movement, aquifer formation, groundwater hydraulics and groundwater recharge mechanism. He/she must have practical working experience in similar projects with hydro-geological investigation, aquifer mapping, groundwater sampling and analysis, pumping tests, design and commission of production wells.	▪ Formulate specification of hydro-geological field investigation and survey. ▪ Assist in the collection, processing and analysis of all types of groundwater related data. ▪ Understand and interpret maps, geological data, historical evidence and models to build up the groundwater regime of the study area. ▪ Supervise installing necessary groundwater monitoring wells and borehole logs and put older wells back into service. ▪ Drill exploratory boreholes in order to obtain missing data. ▪ Perform groundwater sampling and in-situ quality tests at field sites using specialized instrumentation and equipment. ▪ Carry out hydro-geological investigation on site such as hydraulic aquifer tests or pumping tests and evaluate their results ▪ Bring the samples to the laboratory for testing. ▪ Monitor aquifer system, aquifer behavior and subsurface lithology of the study area. ▪ Assist the Team Leader to prepare aquifer mapping for the study area. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
GIS/RS Specialist	02	He/she must have a Bachelor's degree, preferably with a Master's degree, in Geography/Civil Engineering/Water Resources Engineering/ Urban and Regional Planning/Geology/ Environmental Science or any other relevant field from a well reputed university.	He/she must have minimum 10 years of working experience in GIS application, Satellite image processing, analyzing and designing projects using ESRI software (ArcGIS, ArcInfo Desktop, ArcSDE, ArcView) and other software (ERDAS Imagine). He/she must have practical experience in similar GIS related activities in producing GIS coverage, contour maps, Digital Elevation Model (DEM); building and maintaining GIS databases, analyzing spatial and non-spatial data.	▪ Acquire data/maps/reports from different primary and secondary sources. ▪ Design, create and maintain geospatial database and develop maps and aerial photography. ▪ Analyze and interpret results using standard GIS and RS tools and techniques. ▪ Produce GIS based geological and hydro-geological maps of the study area. ▪ Establish surface water and groundwater resources inventory which is compatible to GIS. ▪ Develop a GIS system based on the latest available aerial imagery base map of the boreholes and behavior of the groundwater. ▪ Map potential groundwater recharge areas and aquifer spatial coverage in different parts of the study area. ▪ Prepare GIS based maps of aquifer mapping, water stress areas and water zoning. ▪ Oversee data flow, management and distribution activities to support GIS. ▪ Provide training to WARPO professionals on GIS and RS. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Database Management Expert	01	He/she must have a Bachelor's degree, preferably with a Master's degree, in Computer Science/ Computer Science & Engineering/Electrical & Electronics Engineering/ Applied Physics & Electronics/Statistics/ Applied Statistics/Data Management or any other relevant field from a well reputed university.	He/she must have minimum 10 years of working experience in computer programming, design and implementing database and management information systems for water related projects. He/she must have practical experience in similar projects in developing and maintaining Relational Database Management System (RDMS) with excellent proficiency in C++/C#, Python, NetCDF or other relevant languages. statistical software (R, SPSS).	• Requirement analysis and design of interactive information system for DSS • Develop and design the structure for the DSS • Programming, coding, development of interfacing tools required for the DSS • Design, create and maintain relational databases and data systems in the DSS • Upload all field survey data, GIS based maps and model results in the cloud-based server • Preparation of User's and Technical manuals of the DSS • Installation of the DSS at WARPO. • Provide training to WARPO officials on the use and operation of the DSS • Any activity assigned by the Project Director for the interest of the project • Maintain close contact with the Project Director for briefing his/her output

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Software Developer	02	He/she must have a Bachelor's degree, preferably with a Master's degree, in Computer Science/ Computer Science & Engineering/Electrical & Electronics Engineering/ Information and Communication Engineering/ Applied Physics & Electronics / Statistics/Applied Statistics/Data Management or any other relevant field from a well reputed university.	He/she must have minimum 10 years of working experience in software development and computer programming, design and ICT activities for water related projects. He/she must have practical experience in similar projects in developing softwares with machine learning tools and excellent proficiency in C++/C#, Python, NetCDF and programming (PHP, XML, JavaScript) or other relevant languages.	▪ Contribution to the development of a dynamic cloud-based Decision Support Tool (DSS). ▪ Utilize machine learning for analyzing forecasting and data imputation. ▪ Design and implement features related to real-time ground and surface water, climate data, and historic information within the DSS. ▪ Collaborate with multi-disciplinary teams to integrate water-related data and functionalities into the system. ▪ Ensure the DSS aligns with project goals and effectively supports decision-making in water resource management. ▪ Upload all field survey data, GIS based maps and model results in the cloud-based server ▪ Preparation of User's and Technical manuals of the DSS ▪ Installation of the DSS at WARPO. ▪ Provide training to WARPO officials on the use and operation of the DSS ▪ Any activity assigned by the Project Director for the interest of the project ▪ Maintain close contact with the Project Director for briefing his/her output

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Hydro-chemist	01	He/she must have a Bachelor's degree, preferably with a Master's degree, in Chemistry/Applied Chemistry/Geology/ Environmental Science/ Hydrogeology or any other relevant field from a well reputed university.	He/she must have minimum 8 years of working experience in groundwater management and groundwater quality analysis. He/she must have practical working experience in similar hydro-chemical investigation, groundwater sampling tests, laboratory tests of hydro-chemical parameters.	▪ Assist in collection, processing and analysis of all types of groundwater quality data. ▪ Collect and analyse water samples for physical and chemical parameters and interpret their results in relation to sectoral water uses. ▪ Perform surface water & groundwater sampling at field sites using specialized instrumentation and equipment. ▪ Carry out hydro-chemical investigation and in-situ tests at field level and bring samples to the laboratory for testing. ▪ Responsible for quality analysis for surface water & groundwater at field level. ▪ Supervise the laboratory analysis of hydro-chemical parameters. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Survey Specialist	01	He/she must have a Bachelor's degree and preferably with Master's degree, in Civil Engineering/Water Resources Engineering/ Water Resources Management/Hydrology from a well reputed university.	He/she must have minimum 8 years of working experience in hydrological survey (river/canals cross – section survey, topographic survey, water level and discharge measurement etc.), water sampling and field data collection. He/she must have practical working experience in similar field data collection, discharge measurement, water level gauge installation, river bed material sampling and measurement.	▪ Formulate realistic field data collection plan and schedule. ▪ Participate survey work to be conducted for field data collection. ▪ Lead and supervise the field data collection team with necessary safety measures. ▪ Conduct extensive cross-section survey of river course, distributaries, tributaries and other water channel on requirement. ▪ Water level gauge installation, reading arrangement, discharge and river bed material sampling and measurment. ▪ Inform the status and progress of the data collection activities regularly. ▪ Assist the Team leader in preparation of the detail survey report. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Data Analyst	02	He/she must have a Bachelor's degree in Computer Science/ Computer Science & Engineering/Electrical & Electronics Engineering/ Civil Engineering/ Water Resources Engineering/ Applied Physics/ Statistics/Applied Statistics/Data Management or any other relevant field from a well reputed university.	He/she must have minimum 5 years of working experience in Information Technology, database management, data processing and analysis and statistical analysis of data. He/she must have practical experience in similar projects with data analysis of water level, rainfall, discharge and topographic data with excellent proficiency in statistical software (R, SPSS) and programming (XML, Javascript)	▪ Acquire data/maps/reports from different primary and secondary sources. ▪ Analyze all types of primary and secondary data under guidance from the Team Leader. ▪ Analyze and interpret results using standard statistical tools and techniques. ▪ Design, create and maintain relational databases and data systems. ▪ Assist the Team Leader to preparation of reports by providing data and information. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

Name of the Postion	Nos. of Postion	Educational qualification	Experience	Responsibilities
1		2	3	4
Field Coordinator (Non-Key Professional)	04	He/she must have a Bachelor's degree in any discipline from a well reputed university.	He/she must have minimum 5 years of working experience in fascilitating and arranging field data collection, field visits in similar projects at grass root level with multi-disciplinary and multi-cultural team.	▪ Compile and analyse necessary information related to data collection. ▪ Assist the Survey team for field data collection as and when necessary. ▪ Coordinate and planning of all the field visits of the survey team. ▪ Arrange meetings and facilitate the workshop/ seminars in the study region. ▪ To assist the Team leader in coordinating all the field data collection programs. ▪ Any activity assigned by the Project Director for the interest of the project. ▪ Maintain close contact with the Project Director for briefing his/her output.

02.02.26

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02/02/26

মোহাম্মদ জাহিদ হোসেন
মুখ্য বৈজ্ঞানিক কর্মকর্তা
পানি সম্পদ পরিকল্পনা সংস্থা
পানি সম্পদ মন্ত্রণালয়, ঢাকা