Government of West Bengal

Irrigation & Waterways Department

NATIONAL COMPETITIVE BIDDING

Request for Expression of Interest (REOI) for Consultancy Services

For

ESTABLISHMENT OF INFLOWFORECAST, FLOOD FORECAST AND WARNING SYSTEM IN WEST BENGAL FOR KANGSABATI-KELIAGHAI-SHILABATI AND DWARAKESWAR SUB BASINS

Under

National Hydrology Project

May 2020

Executive Engineer
Burdwan Investigation & Planning Division
Irrigation & Waterways Directorate

NOTICE

Request for Expression of Interest for Consultancy services

for

"Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins."

Memo No: 150/NHP-20/02 **Date: 22.05.2020**

EOI No: WBIW/NHP/01 of 2020-21
Ref No: NHP-2019-2020-WBSW-731524

1. **This Request for Expression of Interest follows the General Procurement Notice for this Project that appeared in Development Business on 9th March, 2017**

2. The Government of India has received financing from the World Bank toward the cost of the National Hydrology Project, and intends to apply part of the proceeds for this consulting service.

3. The Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India is implementing the National Hydrology Project (NHP) in almost entire India with the active technical and financial support of World Bank. Irrigation & Waterways Department, Government of West Bengal is the Implementing Agency responsible for development of Surface Water components in the state. The State Project Management Unit (SPMU) of I&W Department implementing the NHP project as Implementing Agency – Bengal(SW) is the agency requiring the *Consultancy services for Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins.*

4. **The consultancy services for Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins under National Hydrology Project broadly consist of the following:**

The broad objective of this consultancy is:

a) To develop, calibrate and operate comprehensive model/suite of models for real time flood forecasting (level / inflow / inundation maps) of the Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins to support effective flood management.

b) To create Inundation map library for various return periods of rainfall events/ flood events including different scenarios of embankment breach at identified vulnerable locations. This will include flood return periods 2 years, 5 years, 10 years, 25 years, 50 years and 100 years. However, the library is expected to be exhaustive, so that the inundation under a specified set of conditions can be obtained through look up. This is expected to save the time for a real time model run and increase the lead time accordingly.

c) To develop a flood warning system based on the flood forecast utilizing the available hydrological, meteorological, and other data, which can at later stage be further refined to improve the Flood Forecast.

- To integrate all processes for data management, forecast models and dissemination methodology etc., in a single system in GIS environment to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.
- To develop a dashboard for customizing model runs for the rainfall runoff and hydrodynamic models, viewing and analysis of model results.
- To develop web based and mobile based system for disseminating flood warnings, based on the envisaged extent of flooding

d) Training and Capacity building.

e) A brief Draft Terms of Reference (ToR) is attached.

5. The attention of interested Consultants is drawn to paragraph 1.9 of the World Bank's Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits& Grants by World Bank Borrowers dated January 2011 ("Consultant Guidelines") revised Jul 2014, setting forth the World Bank's policy on conflict of interest.

6. The Executive Engineer, Burdwan Investigation & Planning Division I&W Department Govt. of West Bengal now invites eligible consultants to indicate their interest in providing the above required consultancy. Interested consultants must provide information indicating that they are qualified to perform the services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc.)

7. Consultants may associate with other firms/ consultants to meet the necessary qualification criteria or enhance their capability. The EOI submitted by consultants in association should clearly indicate the nature of the association if it is a joint venture or a sub-consultancy. In case of Joint venture, the name of the lead firm should be clearly stated and the maximum number of JV partners including the lead partner, other partner or sub-consultant shall be limited to two.

8. **The short listing criteria are:**

i. The eligible consultants shall be a consultancy firm with minimum ten (10) years experience in providing consultancy services in the water sector, with particular emphasis and a track record of successfully delivering major analytical projects in the field of Hydrological and Hydraulic modeling, flood forecasting and flood inundation modeling.

ii. The firm shall have similar experience (as stated in i above) of providing minimum two similar completed consultancy services contracts to Developing countries/Central Government/State Government/ Public Sector Undertakings each costing not less than Rs 370. Lakhs. In case of the JV, firm shall have similar experience of providing minimum two similar completed consultancy services contracts to Developing countries/Central Government/State Government/ Public Sector Undertakings each costing not less than Rs 370 Lakhs. The lead partner shall at least have completed one similar contract costing not less than Rs 320. Lakhs and other partner shall at least have completed one similar contract costing not less than Rs. 140 Lakhs
(*Documentary evidence indicating the value and acceptance/completion certification should be provided by the consultancy firms***)**

iii. **The firm should have an average annual turnover of Rs 300 lakhs of the last 3 consecutive Financial Years (FY 2014-15, 2015-16, 2016-17 2017-18,and 2018-19) from Consultancy Services** *(Audited financial statements should be provided by the bidder). In case of JV, the lead partner shall have minimum 70 % of the required turnover whereas the other partner shall have minimum 40% of the required turnover.)*

iv. Organization set-up, structure and availability of key professionals (Hydrologic/Hydraulic Modellers, Senior Hydrologist, Water Resources Specialists, GIS/RS expert, Database specialist/web management specialist etc.) of required qualification with the firm i.e. Technical team and expertise available with the organization (attach short CVs for reference only).

v. The consulting firm(s), including the JV partners and sub-consultants, should have at least 40% of the key professionals as permanent employees.

vi. Undertaking towards correctness of information furnished with REOI.

9. **A consultant will be selected in accordance with the LCS (Least cost Selection) procedures set out in the World Bank's "Guidelines: Selection and Employment of Consultants Under IBRD Loans and IDA Credits &Grants by World Bank Borrowers- Jan 2011, modified July 2014". The Guidelines are available at www.worldbank.org/procure.**

10. **Interested Consultants may obtain further information at the address given below from 10.00 – 17.00 hours (IST) on all working days.**

Superintending Engineer, Investigation and Planning Circle II
Irrigation & Waterways Directorate, Govt of West Bengal
Jalasampad Bhavan, 5th Floor, Salt lake, Kolkata 91,
West Bengal, India
E mail: bengalsw@gmail.com; https://wbtenders.gov.in / wbiwd.gov.in

11. Expression of Interest with all relevant information and documents can be downloaded from https://wbtenders.gov.in / wbiwd.gov.in for "Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins" under National Hydrology Project from **23.05.2020, 10:00 hrs. to 22.06.2020, 15:00 hrs.** Server time. The last date/time of submission/uploading of REOI at https://wbtenders.gov.in is **22.06.2020, 15.00 hrs.** Server time The Expression of Interests received till the appointed time and date shall be opened same day at **15.30 hrs.** Server time. In the event, this last date being declared as holiday by the Government, above EOI will be opened on the next working day at the same time.

12. The electronic bidding system will not allow any late submission of the REOIs after due date and time as per server time. Physical, Email, Telex, cable or facsimile submission of REOIs will be rejected as non-responsive. Intending Consultants are advised to visit website https://wbtenders.gov.in / wbiwd.gov.in prior to closing date of submission of REOI for any corrigendum / amendment

The Executive Engineer
Burdwan Investigation & Planning Division
Irrigation & Waterways Directorate
Purta Bhawan, 3rd Floor
Purba Burdwan-713103, West Bengal
E mail: bengalsw@gmail.com / eebipd2012@gmail.com

Annexure-I

Expression of Interest Form for Consulting Engineering Firm or Joint Venture

(To be filled up by each of the constituent in case of a Joint Venture)

1.

Consultant	**Date of Establishment**	**Country**	**Type of organization**			
			Individual	*Partnership*	*Corporation*	*Other*
Name						

2. *Corporate/registered Office / Business Address / Telephone Nos. / Cable Address/ E-mail address of consultant and its branch offices for Consultant (including members in case of JV)*

3. *Consultant's former name and year of establishment (including that of members in case of JV)*

4. *Narrative description of Consultant firms if any (Use other sheet, if necessary)*

Annexure-II

Financial Statement of the five financial Years

Sr. No.	***Particulars***		***2014-2015***	***2015-2016***	***2016-2017***	***2017-2018***	***2018-2019***
1.	*Annual turnover from Consulting business*	*Lead member*					
		other member(1)					
		other member(2)					
2	*Net Profit.*	*Lead member*					
		other member(1)					
		other member(2)					

Notes:

i. *Values should be duly certified by statutory body like Chartered Accountant or Independent Auditors who are competent to do so as recognized by the Government of India.*

ii. *The amount shall be stated in Indian Rupees (INR).*

iii. *For the purpose of short listing, conversion to Indian Rupees shall be based average of the buying and selling rates of Reserve Bank of India as on the Proposal submission date.*

iv. *In case the exchange rate for any currency is not available as per the provision of this section, then Irrigation & Waterways Department, Government of West Bengal reserves the right to use the rate available from an alternative source at its sole discretion.*

Annexure-III

Organizational Strength

1. Staff strength of the Organization/s

SlNo.	**Area of Expertise**	**Total No. of Staff**	**No. with Doctoral Degree**	**No. with Post-graduate Degree**	**No. with Graduate Degree**	**No. of Permanent Employees**	**No. of years with the firm**
i.	Water resource Expert						
ii.	Hydrology / hydrodynamic Modeling Expert						
iii	GIS & Remote Sensing Expert						

Annexure-IV

Details of Experience

Sr. No	Projects Name / Year	Type of services rendered	Cost of the assignment	Client (With complete address, contact person, telephone No. Fax No and E mail address)	Fee in INR (Applicant's share in case of JV/ Consortium)	Completion certificate from client (whether attached)	Project Duration in months	Funding Agency	Sole / JV/ Consortium (if JV-state Lead /Partner with share)
1	2	3	4	8	9	10	11	12	13
1									
2									

Note: Type of services rendered to be as follows

A. Hydrological analysis and modeling.
B. Hydrodynamic analysis and modeling.
C. Flood forecasting and flood inundation modeling.
D. Combination of any of the above services.
E. Any other type of modeling assignment. (Specific type to be mentioned)

Only those assignments shall be considered for which consultant has provided services as lead member in case that work is done by a JV/ Consortium.
Each assignment shall be supported by a performance certificate comprising of the following details:

Name of Project : ……..

Client's Name and Address : ……..

Cost of assignment :……..

Description of assignment: ……..

Description of Services provided by the firm: ……..

Authorized Signatory of client

Annexure-V

Undertaking

To,

The Executive Engineer
Burdwan Investigation & Planning Division
Irrigation & Waterways Directorate
Govt of West Bengal
Purta Bhawan, 3rd Floor
Purba Burdwan-713103,
West Bengal, India

I certify that the information in the above Expression of Interest forms is true to the best of my knowledge. I also understand that any misleading or wrong information will disqualify this application straightaway.

*President/*Managing Director

or

Authorized Signatory

Terms of Reference

For

Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins.

(MAY 2020)

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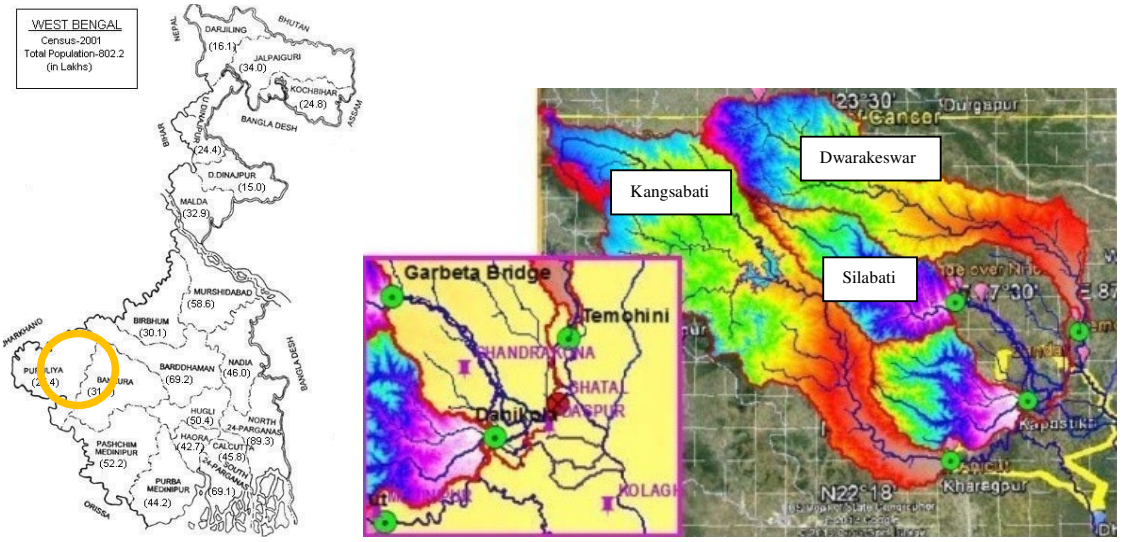
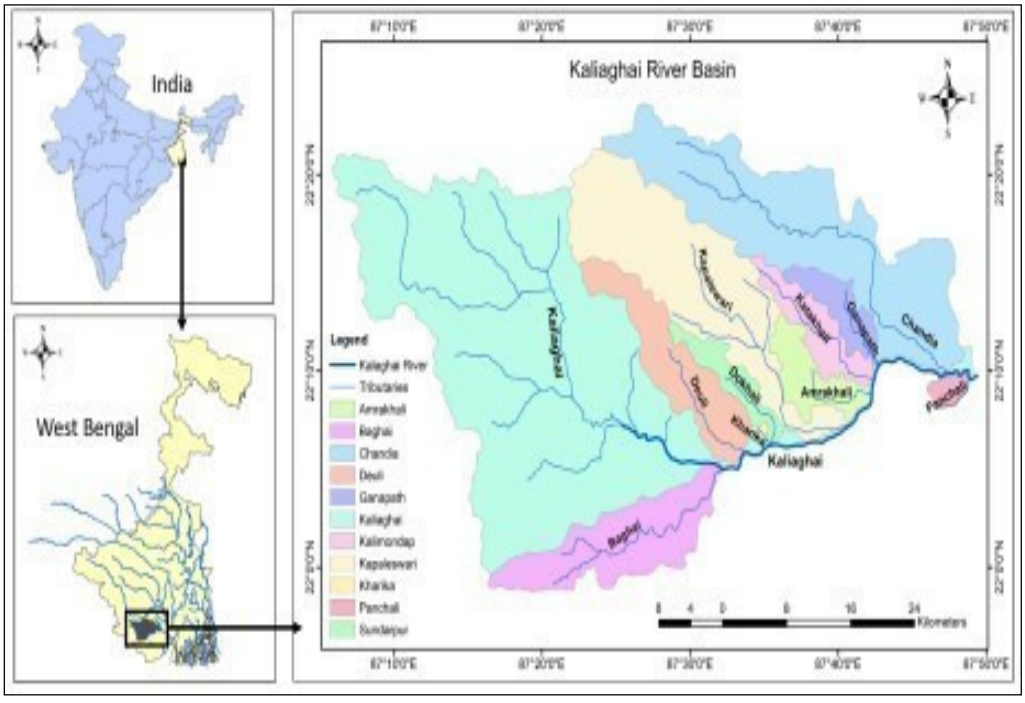
1. BACKGROUND

The state of West Bengal is one of the most flood prone states of India. More than 42 percent of its geographical area is identified as flood prone. Of the different regions of West Bengal which are flood prone, the district of Paschim and Purba Medinipur are one of the most vulnerable. Figure below shows the location of the state and the Kangsabati, Keliaghai, Shilabati and Dwarekeswar basins and its overall location in respect of West Bengal.





Location of Kansabati,Silabati,Keliaghai and Dwarakeswar river basins

Rivers Kangsabati, Kaliaghai,Shilabati and Dwarakeswar regularly inundate large tracts of low-lying hinterland of southern West Bengal, causing immense damage to the natural and the built environment. The floodplains of these rivers, being extremely fertile, bear rich harvest of crops - often thrice a year. Being very fertile it is home to a large human population living in historically old villages and towns. However, untimely rain especially during the convectively active period in the monsoon season result in inundation of the agricultural fields adjoining the rivers, catch the farmers unaware - resulting in great loss of standing crops. Such recurring floods in the region have affected the economy of the area, lives of the inhabitants and also the development of the infrastructure. Therefore, need for effective steps to forecast and take suitable measures for better flood management has been felt.

It may be noted that the region drains the waters of the following important river systems: (a) Kangsabati (or Cossye); (b) Silabati (or Silai) (c) Dwarakeswar and d) Keliaghai. Within the region, the rivers, in turn, break up into further river sub-systems. For example:

Kangsabati, that is Cossye, divides into Old and New Cossye
Silabati divides into another channel named Ketia
Dwarakeswar divides into another channel named Jhumi
Old Cossye further divides into Durbachati and Palaspai
Ketia further divides into another channel named Katan

All the rivers finally drain into the Rupnarayan or the Hooghly which are under the influence of tide.

2. OBJECTIVES OF CONSULTANCY

The broad objective of this consultancy is:

f) To develop, calibrate and operate comprehensive model/suite of models for real time flood forecasting (level / inflow / inundation maps) of the Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins to support effective flood management.

g) To create Inundation map library for various return periods of rainfall events/ flood events including different scenarios of embankment breach at identified vulnerable locations. This will include flood return periods 2 years, 5 years, 10 years, 25 years, 50 years and 100 years. However, the library is expected to be exhaustive, so that the inundation under a specified set of conditions can be obtained through look up. This is expected to save the time for a real time model run and increase the lead time accordingly.

h) To develop a flood warning system based on the flood forecast utilizing the available hydrological, meteorological, and other data, which can at later stage be further refined to improve the Flood Forecast.

- To integrate all processes for data management, forecast models and dissemination methodology etc., in a single system in GIS environment to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.
- To develop a dashboard for customizing model runs for the rainfall runoff and hydrodynamic models, viewing and analysis of model results.
- To develop web based and mobile based system for disseminating flood warnings, based on the envisaged extent of flooding

i) Training and Capacity building.

3. SCOPE OF CONSULTANCY SERVICES

The following basins/sub basins are to be taken up for the development of the hydrologic - hydrodynamic models for Real Time Flood Forecasting coupled with available weather forecast from IMD / IITM or any other reliable sources from which .

Sl no	Name of River Basin	Catchment Area in sq Km	Length of river system in Km	Width of river (Av) in Mtr	Tributaries
1	Kangsabati	6528	525	500	Bhairabbaki, Tarafeni
2	Silabati	4086	350	100	Kubai, Tamal, Parang, Donai, Buri Ganga
3	Dwarakeswar	4252	320	250	Gandheswari
4	Keliaghai – Kapaleswari - Baghai	1875	275	75	Kapaleswari, Baghai, Deuli, Chandia
5	Rasulpur	1554	275	75	Kalaberia, Sadar.Itaberia, Deriadighi, Orissa Coast Canal
6	Pichabani	807	120	65	Negua, Contai nullah, Orissa Coast Canal

Note: Data given above may vary upto ± 15% during actual survey.
The brief description of these basins is as follows:

Kangsabati: The River Kangsabati originates from the Purulia District. After its confluence with river Kumari a dam has been constructed with a flood absorption capacity of 180.43 MCM. Two major tributaries the Tarafeni and Bhairabbanki meet the river at 12.8 km downstream of the dam. The river finally branches out into two different channels old Kasai and New Kasai. The New Kasai finally meets river Keliaghai to form river Haldi and finally outfalls into river Hooghly. The old Kasai further breaks

to form the Kankikhal. The Kanki Khal finally drains into river Silabati. The Old Kasai further breaks into two channels called Palaspai and Durbachati to finally fall into river Rupnarayan.

Silabati: The River Silabati originating from the high land in Purulia District traverses through the districts of Bankura and West Midnapur and finally combines with the Dwarakeswar river to form the River Rupnarayan. Main tributaries of the river being Buri Ganga Kubai Tamal and Donai. The river after meeting river Kanki a spill channel of river Kansabati finally meets Dwarakeswar.

Dwarakeswar: Originating from the upland in Purulia District and travelling through the districts of Bankura and Paschim Midnapur the river Dwarakeswar meet river Silabati to form the river Rupnarayan. The river has a major left bank tributary called Gandheswari falling into the Dwarakeswar just after Bankura town.

Keliaghai: The river system comprises of twelve major tributaries outfalling into the Kaliaghai river. Centrally aligned Kaliaghai river has one right-bank tributary (Baghai) whereas all other tributaries viz river Deuli, Kapaleswari, Kharika-khal, Sundarpurkhal, Aamrakhalikhal, Kalimandapkhal, Ganpat khal, Chandia join the river in its left bank from north-western high-land. The river Kaliaghai joins the river new Cossye at Dhewbhanga to form river Haldi which finally drain into the river Hooghly.

Other than the above rivers two small rivers viz **Rosulpur and Pichabani** flow through the southern area of the basin and outfall into the Hooghly.

The Scope of the Consultancy is broadly divided in two phases as follows:

Phase - I

a) To develop, calibrate and operate a comprehensive model / suite of models involving meteorological-Hydrological-Hydraulic models for real time flood forecasting (rainfall/runoff/Inflow/inundation maps) using hydro-meteorological data, meteorological forecast and other data with desired accuracy.

b) To create Inundation maps for various rainfall/flood events including different scenarios of embankment breach at identified vulnerable locations.

c) To integrate all processes for data management, forecast models and dissemination methodology etc., in a single system in GIS environment to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.

d) To develop a dashboard for customized model runs and analysis of results.

e) To develop web based Integrated Flood Warning System with GIS tool for dissemination of forecast, inundation map, to the departmental officers through

secured departmental website with flexibility to disseminate such information to other stakeholders as per decision of the department.

f) To develop mobile based flood warning system that issues warnings to specified persons and public in general based on pre-defined flood magnitude classes.

Phase - II

Maintenance, updating and running of the model in real time during operational support period of 4 years.

Training the designated officers of the Department / other implementing agencies of the National Hydrology Project.

NOTE: The consultant shall undertake the work/service in consultation with modeling unit of SPMU, NHP headed by Director, Advance Planning Project Evaluation & Monitoring Cell, I&W Directorate.

3.1. Key tasks in Phase - I

3.1.1. Review of Data availability

i) Identification of required data (hydro-meteorological, topographical, and other data required for modeling) for setting up of model, calibration, and validation.

ii) Review of available data and information with respect to minimum and optimum requirement for model development.

iii) Requirement of additional data, if any may also be recommended by the consultant for better performance of the model.

3.1.2. Identification of suitable software and hardware

i) The main frame of the modeling and flood forecasting system should preferably be based on license free or public domain suite of software. The consultant should identify other required software like GIS, remote sensing, database management, web hosting and data dissemination, data visualization. This ancillary software should be compatible with the proposed system or other modeling software as the case may be, and should preferably be license free / public domain software. However, the consultant is free to use any other commercial software/ suite of his choice for the purpose, subject to the condition that no additional payment will be admissible on account of the software, its license or its subsequent upgrades for a period extending two years after the end of the contract period. This is deemed to apply for installations on multiple independent systems (a maximum of four).

ii) The consultant should identify compatible hardware for real time flood forecasting, generation of inundation map, system for data assimilation (automated coupling of input data (HO, MET (station and gridded data in form of QPF and other various state of the art satellite/radar/ any other new technology products) and topography) and output dissemination (Including all necessary, software, hardware and web system) in real time.

iii) Procurement of all required hardware and software in consultation with client, if required, by the consultant during project period and to be handed over to the client after completion of the consultancy.

3.1.3. Data Collection and Validation

i) Collection of required data as and when required from various offices of the Irrigation Department Government of West Bengal or other agencies with prior intimation to the department.

ii) Collection of details of structures across the river reaches that influence their hydraulic behaviour.

iii) Integration of cross sections with DEM to improve model efficiency. To start with, the DEM would be free domain DEM as chosen by the consultant in consultation with the Department. At later stage the model may have to be upgraded by incorporating finer resolution DEM (DEM with 10 m / 1 m resolution prepared using ortho images or LiDAR data) for selected areas. These would mainly include low lying areas suffering from recurring flooding problems. The DEM will be made available to the agency for free. There will be no scope for additional payment due to required model upgrades, and it would be deemed to be included in the original contract value.

iv) Collection of land use / land cover (LULC) data / map / imagery of suitable resolution available in the public domain.

v) Validation of input data for consistency.

vi) Correction and gap filling of data based on consistency check.

3.1.4 Development of forecast models

i) Delineation of sub-basins, river networks and extraction of basin/catchment parameters.

ii) Develop Hydrologic models for estimation of discharge and 2-D Hydrodynamic models for assessment of flooding extent and impact. A GUI – based dashboard should be developed to allow hassle-free running of the models without expert intervention. It should be able to read stored data and collect data through internet from specified websites, carry out hydrologic modeling, apply corrections, carry out hydro-dynamic modeling and present results in user-friendly manner in the form of maps, graphs and tables.

iii) The hydrologic model should also be capable of estimating runoff from rainfall data acquired through RTDAS system installed by the department. It should be calibrated to match with the observed gauge/discharge data and reservoir release.

iv) The proposed system should be able to dynamically generate real time forecast of river discharges and water levels at key locations at different times based on the available Quantitative Precipitation Forecast (QPF) of IMD/other agencies for 3 days or more where QPF is available for longer duration. This should consider the releases from the Kangsabati Reservoir Project, the only major dam in the area. The computations should be based on the latest available area-elevation-capacity curve for the reservoir [last bathymetric survey was carried out in 2012] and the existing operating policy rules governing the reservoir releases.

v) Perform bias correction of using satellite based rainfall data products/forecasted rainfall, using long term historical data. For this purpose, consultant should obtain point rainfall data from ground measurements by the department and satellite rainfall / forecast of same period and perform bias correction for at least 4 recent years.

vi) Model is to be calibrated for minimum 4 recent years including all major peaks to the accuracy satisfactory to the department. Inundation model is to be prepared using DEM and the cross sections as mentioned earlier. The validation of inundation depth is to be done through ground survey.

vii) Model calibration up to desired accuracy. (Level forecast ± 0.05m, inflow forecast ± 10% of flood volume) at 20 gauge stations (to be specified by the Department at a later stage), with a lead time of 12 hours or more. For extent of flooding, the inundation forecast maps should be accurate to± 5% of the observed inundation extent. The arrival time of flood peak should be accurate to half an hour or less. The spatial distribution of peak flood velocity should also be forecast for planning evacuation.

viii) A prime focus of the modeling exercise is to ensure zero death due to flooding in the region considered, and minimize damage to properties to the extent feasible through the issue of forecast. Therefore, a critical element in the contract is to establish thresholds of flood depth for each flood prone locality

that would call for activation of evacuation plan, and issue forecast well in advance to ensure its implementation in a proper way. The forecast of extent and severity of flooding within a tolerable limit of acceptance is of crucial importance as the errors on either side are undesirable. While underprediction may lead to death and extensive damage that is totally unacceptable, overprediction beyond certain margins would speak against the credibility and make grounds for non-compliance to future flood warnings.

ix) Generate real time flood inundation maps showing extent, depth, arrival time, duration and peak velocity. Inundation extent with depths should be validated with high resolution DEM and/ or real time information obtained through mobile applications with facilities for geotagging (crowd sourcing) later and periodic updating of model is to be done.

x) Prepare Flood inundation map library corresponding to different return period of flood flow / naturalized runoff (2, 5, 10, 25, 50 and 100 Years).

xi) Run the models for the river basin using precipitation estimates generated, observed input data and update the model at every 3 hours when peak floods are occurring or are anticipated, and 6 hours otherwise.

xii) Model should be capable of updating the state parameters using observed data and capable of generating short term / medium term ensemble forecast (using forecast products from different agencies) and Probabilistic forecast for longer lead times.

xiii) Based on the pre-defined thresholds of flood category in terms of flood depth and extent, automatic generation of alerts to concerned Executive Engineer/ Chief Engineer/ Secretary of the I&WD/ Block/ District Administration/ Police /State Disaster Management Authority / National Disaster Management Authority/ any other concerned Department as may be identified by the Department/ residents of the area through mobile as WhatsApp and SMS messages is a requirement. The critical thresholds are to be jointly decided in consultation with the Department.

xiv) A mobile application is also envisaged to be developed, to help in capturing depth and extent of inundation through geotagged images, and also to provide assistance in dissemination of warnings.

xv) Model is to be vetted by a premier institute of India like NIH / IIT / IISc etc. (Expenditure to be incurred for this purpose will be borne by the consultant)

3.1.5 Input data assimilation and processing precipitation / level / inundation estimates

i) Consultant will develop work flow for each process to automate collection, validation and management of observed input data (H.O data, releases from control structures, Rainfall (satellite/radar/ rain gage values (including AWS/ARG) /any other new products [in optimum combination]) flow to model.

ii) Automate real-time acquisition of QPF from IMD/RTDAS to be updated at 3 or 6 hour interval (or at specified interval, as decided by the Department).

iii) The whole process of acquiring input data (from various sources like websites, ftp folders etc); processing the data in required format, gap filling and quality check, providing the data as inputs to models, generation of outputs in form of GIS vector layers, raster, maps and tables, updating of outputs on website and databases etc. should be automated and should not require any human intervention at any of the mentioned stages.

3.1.6 Development of Integrated Flood Warning System

i) Develop Integrated Flood Warning System with Graphical User Interface (GUI) for real time dissemination of model output in the form of levels, discharge, inundation extent, depth, arrival time and duration etc.

ii) System should be capable of map and graphical displays, and alerts, for providing:

a. Access to both predicted and present water level/discharge at monitoring station notified location.

b. Access to forecasted inundation maps showing Inundation extent and inundation depth, time of arrival of flood peak and peak velocity of water flow.

c. System should have capability for generating results (query based) for level, discharge, inundation extent, inundation depth, inundation duration, time of arrival of flood peak and peak velocity of water flow, population/area affected upto village level due to flooding.

d. System should have capability of generating flood forecast report, flood bulletins, text messages, animations, flood summary report, report in reply to user defined queries etc.

e. Development of interface for real-time display of results of flood warning system on departmental website as well as mobile alerts (through sms, messaging, WhatsApp) based on envisaged criticality of the event.

3.1.7 Key Deliverables and Reporting

The consultant shall also provide following deliverables for this work:

- **Inception Report**: consultant shall provide an "inception report" clearly indicating how consultant has planned to achieve the assigned objectives of this consultancy. The inception report shall include detailed work plan along with time schedule, selection of database, and finalization of models, data requirement, review of available data and data gaps, if any. The inception report shall indicate the time schedule represented by weekly Gantt chart showing major milestones, task deliverables, completion dates and any interdependencies.

- **Draft Model Development Report**: The consultant will submit the draft model development report within the stipulated time to the client. The report should include broadly the following chapters-
    1. Objective
    2. Study area
    3. Methodology for model development
    4. Data used
    5. Approach for model development
    6. Different forms of model output
    7. Confidence limit in result prediction
    8. Model parameters considered and their Sensitivity Analysis
    9. Uncertainty in model development
    10. Shortcomings in the models
    11. Discussion, Conclusion & Future Recommendation.

- **Final Report:** Consultant shall submit the final report to the client in hard (10 set) and soft copy. Consultant will prepare a paper based on results of the modeling in consultation with the Department for presentation at national and international forums.

- **Operational Training:** Training departmental staff to enable independent handling of the model along with receipt and viewing of output data.

- **Records and Metadata:**
    - ✓ The consultant shall consolidate all data used in development of the mathematical model and data formats as decided in consultation with Engineer-in-Charge.

    - ✓ The metadata records shall be delivered free of errors in both content and format.

    - ✓ The consultant shall deliver all data and data products, metadata records which detail datum, re-projections, re-sampling algorithms, processing steps, field records, and any other pertinent information etc.

- ✓ ***Geospatial data***- in the form of shape files. The consultant is required to submit a file geo database or shape files listing all the geospatial files, with their respective attributes. All the geo-spatial and time series data should be properly catalogued, including basin, sub-basin and other station IDs as provided by the client; and should be consistent with nomenclature used by client.

- ✓ ***Cross section*** - it shall include the hydraulic model cross-sections used to develop the inundation mapping. This will allow the modeling to be archived for future applications and updates to the inundation mapping.

- ✓ Development of technical, operational, user manuals, online help, training presentations and other training material. Provide 5 copies of user manuals (software design, operation and troubleshooting tips) in hard copy and electronic form.

3.2 The key tasks in Phase II include

3.2.1 Maintenance, updating and Running of the model in real time during operational support period of 4 years after acceptance of the Final Report and training the designated officers of the Department:

i. Maintenance of the model including updating of software used for the models

ii. Develop scripts for automatic alert (via email, WhatsApp and SMS) to developers / modelers / programmers/ concerned officers in case the system malfunctions due to inability to download data, unavailability of servers, error in data etc. The consultant should develop an automated system for alert so that appropriate actions could be taken with minimum delay.

iii. Maintenance of the auxiliary systems for coupling real time HO and Met data with the model and data dissemination portal.

iv. Review of model and updating of parameters based on the model performance and improving model results.

v. Incorporation of changes in model in case data from new station/sources are accepted by the department, and further calibration. The recalibration may be required for at least 2 times a year, depending on the data situation and accuracy of results.

vi. Updating inundation map libraries and improvising the technology for real time inundation forecast and dissemination.

vii. Generate real time forecast for identified forecast locations for 3 days or more, depending on availability of forecasted rainfall data.

viii. Generate real time flood inundation maps for reaches/locations identified by the Department to predict inundation extent, depth, arrival time, peak velocity of flow and flooding duration at any location in the basin. Inundation extent with depths should be validated with high resolution satellite later and periodic updating of model is to be done.

ix. Run the models using precipitation estimates generated, observed input data and update the model at every 3 or 6hour, as per requirement.

x. Training field staff to enable independent handling and minor modification/up gradation of the system as data availability increases (e.g. high resolution DEM, observed rainfall from more stations and finer resolution predicted rainfall grids) in near future.

xi. Conducting workshops/conferences addressing the issues faced during real time forecasting and dissemination.

xii. Conducting regular and periodic training of the designated set of officers of the Department (up to 5) so as to enable them to carry out flood forecasting for the project area on their own and develop models for similar other sub-basins in the state after the project period is over. The completion of the project would entail the ability of the officers to continue the forecasting process independently. It is envisaged that the same set of officers designated by the Department will remain associated with the progress of consultancy all along the project. Since major contribution from the consultants is expected from the home office of the consultant, the contribution from the officers would be crucial to ensure that the project moves in the right direction. This process of learning through contribution that may take place through interactions on a day to day basis over the phone and the electronic media will (i) help to build the confidence of the officers and at the same time (ii) help to cut down the expenditure on part of the consultants.

3.2.2 Key Deliverables

- **Half yearly progress report:** Consultant shall provide half yearly progress report of the work carried out by them in the period positively by 10th of the next month clearly indicating achievements, problems faced, likely solutions proposed, and bottlenecks if any in carrying out the task as per TOR.

- **Flood forecasting report:** Consultant shall generate flood forecasting report on real time basis during the monsoon period i.e. June to October every year, giving details of FF sites, observed water levels, forecasted water levels, spatial forecast of inundation area etc. in mutually agreed format, to put it on web.

- **Flood Report:** A flood report is to be generated after the end of each monsoon season. The report will have all the details i.e. methodology, deviation in forecast and actual observed parameters, bottlenecks/limitations, sensitivity detail of model results, all graphical details, performance of real time data transmission system, quality of received data vis-à-vis objectives etc. The consultant will make presentation in the Department organized Flood Appraisal workshop to deliberate these experiences and outputs in this workshop.

- **Comparison of results:** At the end of each monsoon period, the consultant should prepare a detailed comparison report for observed and predicted flow/ levels; and analyze the reasons for discrepancy (if any) and incorporate the changes in the model for improving accuracy during next season. The comparison should also be made for forecasted rainfall vs point observation of rainfall data, and bias correction be updated every year before and after monsoon season.

4. SCHEDULE FOR COMPLETION OF TASKS

A. Phase I:

Sl No	Deliverables	Description	Period	Remarks
1.	Inception Report and Data Collection Report	I. Analysis of data availability and data quality, Review of International experience, Identification of possible models suitable to each river basin, Conceptual design of flood II. Monitoring system, Methodology for the development of model, Identification of data inputs for the model, Outputs expected, Methodology for the calibration and validation of model, and fortnightly schedule of implementation work plan. III. Collection of Required data (hydro-meteorological, topographical, GIS layers including DEM and other data required for modeling)	T+2 months	To be reviewed and approved by a committee constituted by the Department

Sl No	Deliverables	Description	Period	Remarks
2.	Model Development Report	IV. Detailed report of flood modeling stating objective, study area, methodology, data used, model parameters, different approaches, shortcomings etc. as per TOR.	T+8 months	-do-
3.	Development, operationalization, demonstration and approval of Integrated Flood Warning System and submission of Draft Final Report based on preliminary DEM data	i) Detail report on Development of GIS based flood warning system including dissemination of Model output in form of levels, discharge, inundation extents, time of arrival of flood peak, duration of inundation and inundation depths etc. ii) Development of interface for real-time display of results of flood warning system on departmental site for disseminating the forecast/inundation maps. iii) Development of Dashboard for query based generation flood warning/flood inundation maps for the department and display of same on departmental/other website for dissemination as per decision of the client. iv) Dissemination system of flood alerts through web and mobile phones (SMS, email, messaging and WhatsApp), based on pre-defined flood thresholds and corresponding dissemination list. v) Draft Final report with outputs of all tasks	T+15 months	-do-
4.	Final Report based on preliminary DEM data	Objective confirming to all task described in the TOR Operational training of the full system and dissemination workshop.	T+18 months	-do-

B. Phase II

Activities of Phase II will start after acceptance of final report and successful completion of operational training of the full system. Time period of phase II will be 4 years.

Sl No	Deliverables	Description	Period	Acceptance
1.	Maintenance Period	Maintenance and running of the model. Up gradation and refinement of model if required, provide training to departmental staff and submission of Half yearly progress report, Flood forecasting report, Flood report, and Comparison of results as provided in TOR.	4 years	To be reviewed and approved by a committee constituted by the Department
2.	Final report based on LiDAR Data	Final report after up gradation of model based on LiDAR data received from MOWR..	Within 4 years	-do-

5. DATA SERVICES & FACILITIES TO BE PROVIDED BY THE CLIENT:

The following amenities will be provided by the Client:

- Suitable office space with basic furniture and amenities like electricity, water supply, air conditioner and internet facilities
- DEM and cross-section data if available (if not available, consultant will have to make do with SRTM data or other suitable data available in the public domain)
- Nominate counterpart officers to facilitate in implementing and operation of flood forecast and inundation model.
- Consultant has to collect available historic and current data on hydrometeorology, hydrology and hydraulics; available thematic data. The client will facilitate the process in the form of permissions, letters etc.

6. RESPONSIBILITIES OF CONSULTANT

- Conduct and complete the consultancy as per the agreed TOR and scope of the consultancy. Major work under the consultancy is envisaged to be carried out from the Head Office of the Consultant Firm, with visits to the project sites as per requirement. This would allow the personnel engaged in this project to contribute to other projects as well, significantly reducing the financial obligations for the current assignment. This is also perceived to allow more flexibility in participation of senior experts, as the need for

relocation sometimes poses a limitation. The Deputy Team Leader is expected to be the key person in maintaining liaison with the Client for the current assignment. However, it is expected that skeletal staff for troubleshooting of errors in the model runs will be available at the designated project office during the six monsoon months.

- Collect data as needed for modeling from concerned agencies. The consultants will have to acquire real time data from different agencies/networks if required for the Modeling work. Consultant has to bear all expenses on data collection.

- Conduct field visits as required for data collection or to verify model results.

- Undertake digitization / data conversion of source data as needed for modeling.

- Presence of key staffs in departmental premises during operational, maintenance and support period should be ensured.

- Consultant should use appropriate modeling software for satisfactory results. Requirement of all input data for the model, consistency of data, primary or secondary validation should be analyzed well in advance. At later stages, any gap in input data shall not be taken as a reason for poor performance of the model.

- Consultant has to provide all software, data, and source code of all applications after the completion of the consultancy to the client.

7. HANDLING RESTRICTED DATA

The Consultants, their sub-consultants, and the personnel of either of them shall not, either during the term or even after the expiration of this contract, disclose any proprietary or confidential information related to the Project, the services, this contact, or the Client's business or operations without the prior written consent of the Client. Certain data (such as topographic maps in 1:50,000 / 1:15000 scale with heights and contour information, hydro-meteorological data for river system and high resolution DEM) which may be used in development and operation of flood models may be considered “restricted” as per Ministry of Defense and Department of Water Resources, Ministry of Jal Shakti guidelines. Keeping in view security guidelines for data secrecy and to provide optimum functionality and to enable sharing data with the consultants, a secure data handling environment has been proposed.

The unit will be equipped with necessary hardware and software and peripheral units but will not be connected with outside LAN network. CD/DVD Writer & Floppy/ Pen Drive facilities will only be available on the main server. Entry to the confidential unit shall be appropriately screened for authorization. Proper record of date and time of entry and exit in the confidential unit along with the details of work done shall be recorded in logbooks. Entry to office will be strictly prohibited before and after office hours. For emergent circumstances approval of competent authority will be required. Permanent passes for the consultant staff deputed for working shall be issued by the competent authority. Confidentiality and non-disclosure Agreements are to be signed by the Consultant firm, as well as the individual Consultants deputed for working. Technical data brought by the Consultant may be allowed to be loaded on the server. No original data kept on server will be modified or changed. Change/ modification required if any will be done only after copying the data.

8. CONSULTANT AND THEIR KEY TEAM QUALIFICATION

The lead organization for the project will meet the following criteria

- Minimum ten years of experience in providing consultancy services in the water sector, with particular emphasis and a track record of successfully delivering major analytical projects that directly interface with water resources policy or management.

- Demonstrated experience in Hydrological modeling, flood forecasting at basin scale in the last five years. Consultant with experience in flood inundation forecast is desirable.

- Ability to quickly deploy a team (professionals with relevant experience and qualifications) either from the lead organization or through sub-contracting arrangements.

Sl. No.	Position	No of persons	Required Qualification	Person-months
1	Team Leader	1	Relevant advanced academic degree in Hydraulics / Hydrology/ Water Resources with 15years of work experience in water resource sector. Preferably has the knowledge of hydrologic and hydraulic modelling tools used in flood forecasting.	4+2
2	Deputy Team Leader	1	Relevant academic degree in Water Resources with 12 years of work experience in water resource sector. Preferably has having field level experience in water sector & having executed government projects and knowledge of modelling tools used in hydrology / hydraulics.	6+3+4
3	Senior Hydrologist	1	Post-Graduation in Hydrology, Hydraulics and/or Water Resources engineering with at least 10 years' experience in hydrologic analysis in flood modelling. Should have a very good experience with rainfall-run-off modelling. Should have extensive knowledge of hydrological and hydrodynamic modelling in flood forecasting. Preference to be given to those with flood modelling experience on Indian river basins.	8+2+1
4	Junior Hydrologist	2	Graduation in Hydrology, Hydraulics and/or Water Resources engineering with at least 5 years' experience in hydrologic analysis in flood modelling. Knowledge of hydrological and hydrodynamic modelling in flood forecasting.	2×(11+6)+1×4×6
5	GIS Specialist	1	Post Graduate in Geoinformatics/Equivalent Degree with 5 years' experience in RS/GIS applications for resource mapping, preparation and integration of GIS data sets including processing of DEMs. Preferably has the experience in hydrologic applications, 3D analysis and customization and experience in flood inundation mapping.	6+3+0
6	IT /Database Specialist	1	Must be a MCA holder or BE / B Tech in Computer Science with at least 5 years' experience in database projects; with at least one full project implementation, involving GIS/RS/Database preferably with Oracle spatial / Oracle environment.	6+3+4
7	Other Technical Support Staff	1	Engineering Graduate; good command over Microsoft Office components; Experience in similar role preferred	11+6+4×6
8	Support Staff	2	Basic Degree. For the data collection and Liaison services	2×(11+6+4×6)

9. DURATION OF CONSULTANCY

18 months for model development + 4 years (Operational Support, up gradation, refinement, recalibration)