

Terms of Reference

for

Consultancy Services for Management Support to the Mathematical Modelling Centre (MMC) for Water Resources Research & Development under Water Resources Department, Government of Bihar

1. BACKGROUND

Traditional efforts at flood management in North Bihar have so far focused mainly on hard solutions, such as the building of a system of flood protection embankment and anti-erosion measures. Despite the heavy investments in largely structural solutions for flood management in the past decades, the threat of floods still remains severe and embankments continue to be vulnerable to sudden and disastrous failures, to the detriment of economy and development of Bihar.

The Government of Bihar (GoB) has initiated action to establish an institute with centres at Patna and Birpur. This is intended to provide world class services in the field of Water Modelling, Computational Hydraulics & related sciences for improved integrated Water Resources Planning and Management.

The proposed *Centre for Research and Development on Water Resources and Flood and Sediment Management* will have one station at Birpur for physical modelling (Physical Modelling Centre (PMC), Centre of Excellence(COE)) and one Centre at Patna for mathematical modelling (Mathematical Modelling Centre (MMC), Centre of Excellence(COE)). These will use state-of-art technologies for better flood management, river basin management, river erosion, sediment management, climate change, water resources planning for new project, instrumentation and software. The Centre will also provide training to WRD officials to support the management of natural resources in the state of Bihar using modern tools like modelling technology, integrated environmental analysis, Geographic Information System, Remote Sensing and Information Technology for sectors like water, land, agriculture and environment in addition to research and development .

The MMC, under a regular capacity building program, will require at least a few years to be self-sustainable and intensive on the job training to be able to produce reliable outputs. However, it is the need of WRD, Bihar to have immediate usable outputs from this Centre. **Thus, a managing consultant is required not only to manage the MMC and**

help in its operational and functional activities, but also to take over the responsibilities of the immediate modelling tasks assigned to the Centre.

A Detailed Project Report has been prepared to establish a Mathematical Modelling Centre (MMC) which inter-alia describes the Management Structure, policies, tasks, roles and responsibilities of authority and staff at various levels for Phase I amidst other details. It also contains tentative directions for Phase II as indicated in Annexure I describing the Concept Outline, areas of work, organisation structure, staffing, work plan and activity timeline of Phase I. The Managing Consultants (MC) will also be responsible for internalising all modelling skills in close consultation with the main management of MMC and also WRD, Bihar. Annexure I contains a detailed description of the objectives of MMC and its organisational profile to provide further guidance to the Consultants.

2. OBJECTIVES

The overall objective of engaging the Managing Consultant (MC) is to develop sustainable internal capacity in the Water Resources Department to independently carry out mathematical modelling for various facets of water resources development including flood and sediment management and erosion management of Ganga basin in general and rivers of Northern Bihar like Kosi, Bagmati, Mahananda and Gandak in particular.

The Managing Consultant will be required to manage the MMC and help in its operational and functional activities and will be fully responsible for the immediate modelling tasks and its deliverables assigned to the Centre for a period of thirty months. In the Phase I of the project, these objectives can at best be categorized as immediate and medium term objectives

2.1 Immediate Objectives

- a) Assist the FMISC, Director, MMC and Division Heads of MMC in selecting staff of appropriate qualifications and aptitude to work in the MMC and provide and/or facilitate the provision of training necessary to rapidly upgrade the skills of this by working hand in hand in modelling, field measurements and data processing tasks.
- b) Adapt to the 1D and 2D modelling software chosen by the client for hydrodynamic modelling, sediment transport, flood modelling, morphological analysis and modelling, erosion modelling and other facets of water resources

development for the activities (under Phase I) defined in the DPR and also other activities agreed with the client in this Phase.

- c) Assist the identified WRD and MMC staff in the selection of modelling tasks of MMC utilising the Software acquired for this purpose and be directly responsible for all modelling tasks of the MMC as agreed with the client.
- d) Provide and/or facilitate the provision of additional formal training necessary to rapidly upgrade the skills of MMC staff in modelling, field measurements and data processing
- e) Take charge of the activities of the MMC in its initial period of operations and ensure timely delivery of high quality outputs to the satisfaction of the Client.
- f) Working together with WRD to develop a team of modellers who will acquire skills to independently extend the already developed models and develop new models for various facets of water resources engineering and to gradually phase-in as the external consultants gradually phase out.
- g) Based on the experience of the first 18 months, determine the adequacy of existing modelling and data processing software and make recommendations for future actions if any.
- h) To establish operation and maintenance practices, supported by guidelines and documentation, for keeping the infrastructure of the Centre in full working order throughout.

2.2 Medium Term Objectives

- a) Create the necessary institutional set up and to introduce management practices in keeping with the future plans for running of the MMC as an independent self- funding Centre of Excellence
- b) Expand the fields of activity into new areas and for planning future activities to be carried out beyond the end of Phase I
- c) Planning and Budgeting for Phase II and laying down procedures for the managing Phase II in a sustainable way.
- d) Developing internal trainers and necessary training tool kits for training new modellers who would be posted/recruited in MMC.

3. SCOPE OF WORK

In order to achieve the aforesaid objectives a three pronged approach will be followed comprising of the following:

A. Management

Working hand in hand with the members of the main management, HOD's and units of the Mathematical Modelling Centre (refer Sections 1.2 & 1.3.2 in Annexure I), to provide advice on gradually introducing new evaluation and management methods, including quality performance evaluation techniques, time management techniques and project costing for efficient implementation and adaptation of improved practices and working of Centre.

Institutional Management

For effective Institutional Management, it is a pre-requisite that the Consultant and the client work hand in hand and share accountability to make the project successful. In order to achieve this, the following will be required:

- Creating an enabling environment for knowledge base development and learning at the start of the project;
- Review and modification of existing rules and procedures that impede development of skills and expertise for highly specialized mathematical modelling;
- Developing and implementing systems of accreditation within the WRD for assessing the level of expertise attained and linking it with the appointments in MMC;
- Identification and application of change agents that can accelerate the realization of objective and vision of MMC;
- Developing process documentation and monitoring tools;
- Periodic evaluation and course correction.

The Managing Consultants will be required to work together with WRD to carry out the above mentioned task.

The consultant shall perform an analysis of conditions towards the last quarter of Phase I, together with WRD to assess the capacities developed in the MMC during this phase and suggest requirements for the next phase. In case of an agreement between the consultant and WRD, that the sufficient in-house capacity has been built, the consultant will have to phase out which implies that Phase II will be carried out by the MMC, WRD by in-house capacity. Alternatively, the continued involvement of the Managing Consultant for the next phase will be mutually agreed to between the consultant and WRD. However, in this case it must be kept in mind that the ultimate goal in due course will be to institutionalise the process as soon as possible without compromising on the quality.

In case of the first condition being met, the consultant shall formalize new management concepts and practices in close consultation with the Senior Officers of WRD, Joint Director of FMISC, Director, MMC and other concerned Officers. In case of the second condition being met, a renewed contract will be signed between the Managing Consultant and the Client/WRD as per mutual agreement.

B. Supervision & Participation in Tasks (Crash Programme)

The Managing Consultant shall carry out an accelerated programme of modelling (utilising the software already acquired by the MMC) to produce and report the results urgently demanded by WRD using the resources (staff, software, equipment) of MMC and with direct participation of the Consultants' Team.

The crash programme will include a few several modelling tasks to be delivered by the Consultant Team during Phase I. Most of these modelling tasks are connected with internalising and refining the various river network models developed in Bihar and building on a regional network model.

In the crash programme, the Managing Consultant shall do the following:

- a. Actively supervise and lead the modelling teams on building the framework models of the Hydrology, River Basin Water availability and utilisation, River Network 1-Dimensional Hydrodynamic Model as well as Flood Inundation Modelling

Task 1: will require that the existing flood forecasting model of Bagmati be refined and automated with incorporation of a warning dissemination system. Also, the other mathematical models already existing with the client will require to be refined and included to make it operational.

Task 2: will require building a Regional Network Model comprising the Kosi River, Bagmati, Gandak and Mahananda and a long enough reach of the Ganges. The Regional model cannot be built in one step. It has to be built up as data becomes available and calibrated over and over again, while gradually including rivers from adjacent basins. This is a long process – the several rounds of model improvement will last; probably 12 months (the work has to be reported twice during the process). At each stage the Regional Network model would be enlarged with additional rivers being included in the network.

Task 3: After Task 1, the forecasting model for Bagmati would already have been included. Task 3 will require that the Regional Network Model be developed in parts as a flood forecasting and warning model for more basins. The data requirement for this step is huge – including flood plain

topography from LiDAR surveys and DEM data publicized on the Internet. The Consultant will make special efforts to make this a viable system before the end of Phase I.

- b. Actively supervise and lead the field survey team: Introduce new field measurement techniques and create a new institutional culture where all modellers must have direct experience of field conditions and measurements so that they are able to experience the relationship between field conditions and model schematization. They must also assure quality control of field practices and gradually introduce a system for the same.

Task 4: will require the consultant to direct and assist in carrying out satellite image analysis and field inspections to identify one or two reaches of the Kosi River most under threat from the next flood season.

- c. Actively supervise and lead the modelling teams in setting up, calibrating and verifying sediment transport models including 2-dimensional morphological models for investigating observed phenomena and for testing design proposals for river bank protection and river training works for their effectiveness and for downstream impacts.

Task 5: requires that the Consultant, with assistance from the MMC staff, set up a two dimensional morphological model for simulating river erosion processes. It is envisaged that a much more extensive and intensive data collection programme would have to be mounted to collect the detailed data needed for developing this model. It is expected that the first report on a morphological model will be available for review midway through the second year of Phase I

Note, that the above tasks will initially be carried out for the Kosi Basin followed by other basins of Bihar. A more proactive role would have to be played by the Managing Consultant in sedimentation study and modelling as it is necessary to obtain early outputs in this area that requires more complex and advanced modelling skills which would require longer association to acquire requisite knowhow.

C. Training & Sustainable Transfer of Technology

(i) Training

The Consultant shall ensure on the job training of the staff employed at the MMC for different activities in various departments and units.

The consultant shall also conduct and supervise full-fledged formal training courses for the MMC staff based upon capabilities and need on flow and sediment modelling, field work, database management etc. This has to be carried out to train the identified staff of WRD to a level that they can independently modify, augment and run the available models and to adapt them to the software chosen by WRD. In the process, the WRD Team will be expected to acquire skills to find solutions to the new problems independently by the end of the assignment. The aim shall be towards developing a Team of Internal Trainers among WRD staff.

In addition to the above mentioned trainings, the consultant shall organise trainings for senior officials on basins with similar issues as faced by Bihar in India and abroad (**refer section 1.7 of Annexure I**).

The Managing consultant will be responsible for the quality control of these trainings and also gradually prepare training kits to be used for training other new staff.

(ii) Sustainable Transfer of Technology

For the sustainable transfer of technology, the Managing Consultant shall do the following with active participation and substantial tasks being carried out by the local staff at the MMC:

- a. Begin a mixed programme of data analysis, training and working with and refining existing models to provide some standard framework models such as the Kosi- Ganges model for use by other modellers
- b. Lead field measurement teams for surveys and directly use the data gathered for setting up and/or calibrating models
- c. Develop new models in response to problems experienced in the field
- d. Prepare check lists and guidelines for the various activities of the MMC
- e. Develop Training Tool-kits for training new staff of WRD internally for the software chosen by WRD.

4. DELIVERABLES

SL. NO.	DELIVERABLES
1.	<p><u>Inception Report</u> to be delivered three months after commencement:</p> <p>The report will contain the following:</p> <ul style="list-style-type: none"> (i) Data Assessment Report – an inventory and quality screening of the data already acquired and actions required in the future, (ii) A Staff Assessment Report – An assessment of the staff recruited so far, their qualifications and any shortcomings to be addressed

	<ul style="list-style-type: none"> (iii) An assessment of the available models recently transferred to MMC, (iv) An assessment of the immediate modelling needs of FMISC/WRD and how this could be addressed (v) A work plan and budget for execution of the Crash Programme (vi) A work plan and budget for the training proposals (vii) An Expert Deployment Plan
2.	<ul style="list-style-type: none"> • Progress reports at 3 monthly intervals the first one – Progress of work and schedule of deadlines met, and recommendations for improving performance with reference to the first report on Task 1. These reports must also include process monitoring & evaluation and agreed course correction for each quarter.
3.	Interim Report after 12 months from submission of Inception Report outlining the work done at this stage, including the completion report on Task 1 and Task 2 and inception of Tasks 3, 4 and 5, with appropriate recommendations including a management plan and institutional structure for the future MMC; a full review of the existing software; recommendations on future acquisitions, and a revised expert deployment plan with justification.
4.	<ul style="list-style-type: none"> • Training tool-kits for all the software selected by WRD between the 24th and 27th months of Phase I.
5.	Draft Final Report after 24 months from submission of Inception Report making a full assessment of the success of the consultancy so far and making recommendations for the continuation or otherwise of the assignment – including a full report of the consultations with the Joint Director of FMISC, the Head of MMC and donor representative(s) regarding the Consultant’s performance. This report will also include the completion report on Tasks 3, 4 and 5, with special attention to sustainability issues and will make practical proposals for fostering a long term self-financing institution.
6.	Final Report in the 30 th month. This report will also include the complete Reports for Tasks 1, 2, 3, 4 and 5. Additionally, the report will also contain the assessment report covering management, trainings, modelling tasks and policies for Phase I and a blueprint with recommendations for Phase II.

Chronology of Report Submission:

Report No	Submission at the end of months from Start	
1	3	Inception Report (QPR-1)
2	6	Quarterly Progress Report 2
3	9	Quarterly Progress Report 3
4	12	Quarterly Progress Report 4
5	15	Interim Report (QPR-5)
6	18	Quarterly Progress Report 6
7	21	Quarterly Progress Report 7
8	24	Quarterly Progress Report 8

9	27	Draft Final, Report (QPR-9)
10	30	Final Report

The major reports shall be submitted in 5 (five) hard copies and a soft copy (Word & PDF) to the Joint Director, FMISC within 10 days of the respective reporting period. Five hard copies of the finally approved report by the Standing Review Committee shall also be submitted for record.

PAYMENT SCHEDULE:

Payments to the consultants will be based on the 10 invoices each raised corresponding to quarterly submissions of Reports made as listed above. The time-based remuneration costs of consultant staff will be invoiced on the basis of the individual timesheets based on deployment of staff duly approved by the Client and the reimbursement of expenditure and scheduled costs will be made on the submission of appropriate documents.

APPROVAL COMMITTEES AND THE REVIEW PROCEDURE:

The reports will be reviewed, accepted and approved by the Standing Review Committee (SRC) constituted by Water Resources Department, Government of Bihar within 30 days after their submission by the consultant. The Consultants shall be liable to incorporate the suggestions advised by the SRC for modification of the Report.

Obligations of the Consultant

- The consultant shall follow the tasks and activities defined in the Terms of Reference and also adhere to the concept outline for the MMC (Annexure D).
- The consultant will undertake to deliver the outputs described in the Crash Programme - The tasks and schedules of deliveries resulting from the crash programme will be specified in the Inception Report
 - The consultant will undertake in collaboration with MMC, the preparation of the tasks to be included in the work plan following up on the completion of the crash programme.

- The work is to be carried out by the teams assigned by MMC and supervised and guided by the Consultant .
- The Consultant would assess and anticipate any training needs that could arise during the execution of these tasks and would take appropriate action for its implementation.
- There will be joint quarterly progress reviews of each task by the WRD/FMISC/ and the consultant would ensure timely execution or to give early warning of a deficit of resources, skills and/or manpower which could cause delays or inability to meet quality standards.
- The consultant would also conduct extensive dialogues with stakeholders for preparing recommendations for the longer term institutional plan for MMC – including its relationship with its parent body Water Resources Department.
- In case, the Physical Modelling Centre (PMC) is operational during the tenure of employment of the Consultant, the Consultant will ensure synchronization of the two viz. MMC and PMC for joint research and other projects.

CLIENT'S OBLIGATIONS

- The Client will be expected to work as a partner with the Managing Consultant to realize the objective and vision of the Centre of Excellence. It will be an obligation to create an enabling environment for the successful implementation of this assignment, and to provide timely feedback and guidance, including timely approvals of (or comments to) the various progress reports and expense statements.
- The Client will provide necessary counterpart staff for working in the modelling teams and for receiving the various types of training that are being provided.
- The FMISC would participate in all committees that are set up for discussing and monitoring the progress and processes for the work programme of MMC.
- WRD/FMISC and the Managing Consultant will jointly decide the course correction every quarter based upon process documentation and monitoring.

The client would try to ensure that a core group of senior staff are offered long term appointments at MMC.

SUGGESTED KEY STAFF

The consultant will engage the key experts with minimum required qualifications and experience as detailed below. Consultant shall make his own assessment for the requirement of any additional key or non-key experts/staff, which he feels is required for the successful and satisfactory completion of the services. Consultant shall quote accordingly payment schedule.

SUGGESTED KEY STAFF

Nos. Of Experts	POSITION	MINIMUM QUALIFICATIONS AND EXPERIENCE	SUGGESTED MAN-MONTHS	ROLES AND RESPONSIBILITIES
1	Senior Water Resources Modeller (Team Leader)	<ul style="list-style-type: none"> At least a Master's degree in Hydrology/Water Resources/Hydraulic Modelling 15 years experience in Water Resources with at least 10 years experience in river flood modelling, sediment transport and water quality, Flood control and river training works Experience in Technology Transfer and institutional reform 	24	He/she will be responsible for setting up (as well as accepting transfers of existing models) and quality control of all hydrological and hydrodynamic models; Training and Advising Modellers and at all levels; Managing the entire team of consultants and ensuring timely outputs - communicating with the Head of MMC, Head of FMISC
1	Morphologist (Deputy Team Leader)	<ul style="list-style-type: none"> At least a Master's degree in Hydrology/Water Resources/Hydraulic Modelling 10 years experience in hydraulics of heavily sediment laden rivers, and erosion control 10 years experience with computational hydraulics including 2-D river modelling and morphology 	18	He/she will be responsible for setting up (as well as accepting transfers of existing models) and quality control of all sediment transport models - as well as schematising the related hydrodynamic models; Training and Advising Modellers at all levels; Supervising sediment sampling and analysis. In the absence of the Team Leader managing the entire team of consultants and communicating with the Head of MMC, Head of FMISC
1	DSS Expert	<ul style="list-style-type: none"> At least a Master's degree in any engineering sector or information technology professional qualifications in software engineering 8 years experience in software development and development, DSS systems for water resources 	12	He/she will be responsible for setting up Decision Support Systems, Data Acquisition Systems, and links with other databases and asset management systems; Writing the necessary software and liaising with the modelling expert's teams on getting the correct conditioning of model results suitable for DSS applications and real time DSS.
1	Field Survey Expert	<ul style="list-style-type: none"> at least a Bachelor's degree in surveying or electronics Specialist knowledge and more than 10 years experience in River Survey techniques and advanced instrumentation including Acoustic Doppler Profilers Experience in Asian sediment laden rivers 	12	Training, guiding and advising the field measurement teams (mainly in river surveys) which will also comprise modelling engineers as well in programming and handling advanced instrumentation and navigation software; Creating outputs of acceptable accuracy and format, plotting survey results
1	Institutional & Management	<ul style="list-style-type: none"> at least a Master's Degree in Water Resources and Research 	5	His/her main responsibility will be to assist and analyse management

Terms of Reference

	Expert	<p>Management</p> <ul style="list-style-type: none"> • Expertise in Institutional Sustainability • Experience in multiple Asian countries • Minimum of 5 years of relevant experience 		<p>strategies and other operation techniques for the MMC. At the end of Phase I he/she will be responsible for creating a report of recommendations for the next Phase.</p>
1	Training Expert	<ul style="list-style-type: none"> • Master's degree in Water Resources Engineering and a degree in Management • Expertise in developing Training strategies/ capacity building • Minimum of 5 years of relevant experience 	5	<p>His main responsibility will be to accelerate the process of internalization of modelling skills. S/he will work closely with the Team Leader to develop training tool kits that shall be used to train the future modellers.</p>

Nos. Of Experts	POSITION	MINIMUM QUALIFICATIONS AND EXPERIENCE	SUGGESTED MAN-MONTHS	ROLES AND RESPONSIBILITIES
3	<u>Unspecified Modelling Specialists</u>	<ul style="list-style-type: none"> • At least a Master's degree in Water Resources or related fields with minimum 5 years professional experience. • Specialist experience in one of several fields of work dealt with at MMC, including River engineering design, information technology, image data processing, database management etc 	30	

Duration Of Consultancy- 30 Months

ANNEX I. CONCEPT OUTLINE OF MMC

1 CONCEPT OUTLINE–MMC

1.1 AREAS OF WORK: DOMAINS

It is important to have well-defined areas of work i.e. “Domains” within the framework of which the activities of the MMC may be defined.

There will be 4 domains of work that will be carried out at the MMC as indicated in

Figure 1

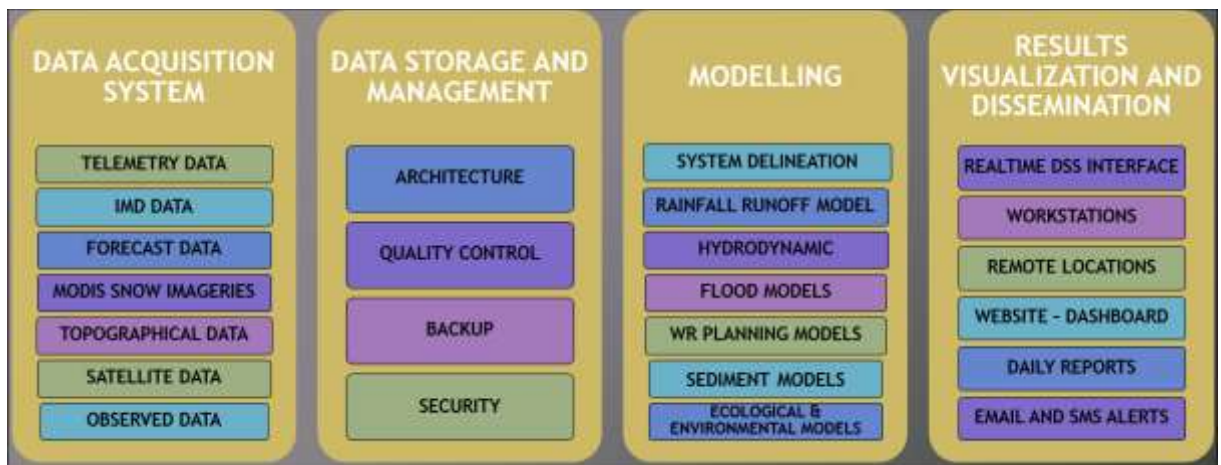


Figure 1- Domains of MMC

All four domains of work will be required to meet the objectives that have been envisaged for the MMC in Phase I and Phase II (maybe revised at the end of Phase I). A process of Quality Control at different levels of management (Divisions and Units: section 1.2) for their individual outputs will assure the smooth running and upkeep of the different domains.

Data Acquisition System:

The Database at MMC is to be linked dynamically with the Data Centre, K-EAMS, BA-EAMS and well as the various other field data acquisition systems for other basins of Bihar and Ganges Basin, developed within WRD, Bihar and also other Organisations.

The Data must include the following:

Telemetry Data

IMD Data

Forecast Data: Rainfall and Temperature

Snow Data

Topographical data (LiDAR, SRTM etc.)

Satellite Data- Precipitation, land use etc.

Manually observed & surveyed Data: Flows, Water-Levels, Sediment, Cross-section data etc., Hydrometric data from WRD, CWC etc., Demographic Data...

Note:As flood modelling is an imperative for the Bihar basins and because the slope of the land is extremely flat, SRTM data is not sufficient. This makes obtaining LiDAR data a good option. Also, the LiDAR data if obtained regularly, would provide information of the area within the embankments which will help the study of sediment deposition and erosion. Lidar data will be most beneficial when taken in the pre and post monsoon period because it does not give accurate data for the river corridor and thus cannot replace the process of measurement of cross sections. It is recommended that the LiDAR data be validated during the manual cross-section surveys. Its procurement maybe carried out through tendering, if and when required.

Data Storage and Management

This domain should accommodate the following:

Architecture: A robust and comprehensive database containing the data obtained by the DAS in a fixed format and structured nomenclature will have to be maintained (both historical and Real-time).

Quality Control: Before the data is added to the database, quality control filters must be applied.

Backup: A daily backup to the server as well as monthly backup from server to the disks must be systemised.

Security: A well thought out security system must be managed at various levels of authority.

Modelling

The modelling domain will accommodate the following Sections:

System Delineation: This will include the GIS based analysis, mapping of various layers and also the river network with appropriate catchment delineations. This section will also have to associate the spatial data with the non-spatial data.

Hydrological Models: This section will deal with the rainfall runoff and snow-melt modelling.

Hydrodynamic Models: This section will deal with all the tasks starting from cross section analysis to the calibration and validation of the river network models. It will also deal with 2 dimensional river models

Flood Models: This section will include all aspects of 2 dimensional flood plain models.

WR Planning Models: This section will include optimisation models for irrigation and water resource planning.

Sediment Models: All models dealing with sediment transport and morphology will be included in this section.

Ecological & Environmental Models: This section will include models dealing with water quality and other environmental problems.

Result Visualisation and Dissemination

This domain will be responsible for receiving the modelling results and completed models to setup real-time DSS interfaces which should be accessible from the workstations in the MMC and also from relevant remote locations. It will also include the responsibility to setup websites/dashboards, generate daily reports of the day to day working of the MMC and generate emails and SMS alerts whenever required. It will also prepare presentations of model results and flow visualization animation for publicity purposes.

1.2 STRUCTURE OF MMC

1.2.1 Ownership and Main Management

Ultimate Aim

Of the ownership models available, the model adopted by IWM and CEGIS in Bangladesh – which runs a close parallel to that of DHI in Denmark is probably suitable for the COE of Bihar.

The organisation from the start should have a vision of becoming a non-profit distributing Institution owned by an independent Trust, with the government control in the form of having the Principal Secretary of WRD as the Chairman and also some other prominent representatives amidst other permanent members.

The Government's role in the Centre shall be 4 fold:

- Ownership: Appointment of director and BOT members; endorsement of strategic directions while gradually detaching from the day-to-day management in order to push the Centre towards its operating Independence
- Primary service user: Client/contract holder

- Resource provider: Core staffing, core funding
- Facilitator of relations between the Centre and its various service users and institutional collaboration partners

Main Management Structure while Starting Out

Initially, a slim and defined structure for the main management completely under the government’s control is proposed. This initial Main Management Structure of the MMC as shown in **Figure 1** is recommended, which from one phase to the next should evolve by adapting to circumstances and need to move towards the ultimate vision.

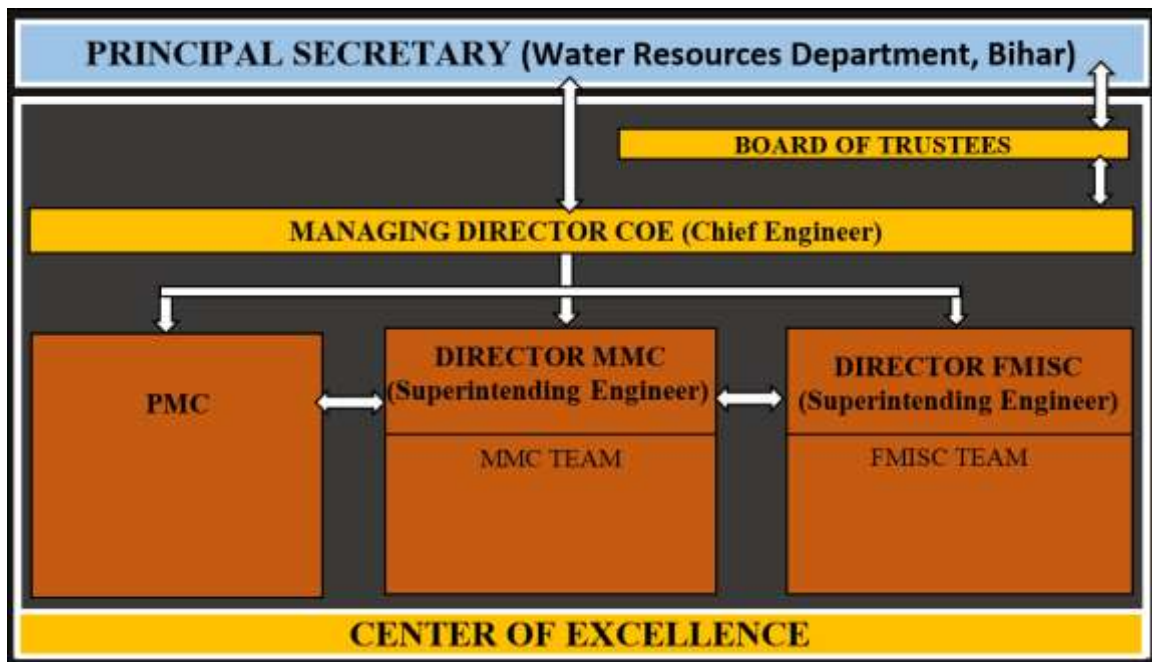


Figure 1 - Main Management Structure Recommended Initially for MMC

The main members of the board of trustees while starting out shall consist of the following:

- Secretary/Principal Secretary of WRD, Bihar (Chairman of Board)
- Engineering Chief (Vice-Chairman of Board)
- Director of COE (Member Secretary of Board)
- Relevant Chief Engineers to be selected by the Chairman of the Board

Additional observing members of the BOT may include, relevant World Bank representative and main representative of Managing Consultant.

Whenever required, **guest attendees** including senior professionals and academics may be invited.

Roles & Responsibilities of Main Management while Starting out

The Secretary/Principal Secretary

- Appointing and replacing the BOT members
- Appointing Managing Director for the COE from the rank of Chief Engineer to supervise both FMISC and MMC
- Appointing and replacing the Director MMC and Director FMISC Head from the rank of Superintending Engineer in consultation with the appointed Director of COE
- Appointing Management Consultant for COE
- Serving as the BOT chairman
- Providing guidance to the Director MMC through Managing Director of COE as required
- Introducing new roles and responsibilities and revising existing ones of the BOT, Managing Director of COE, Directors of MMC, FMISC, PMC (when it gets established)

The Board of Trustees

- Overseeing the general MMC operation, and its orientation towards provision of science-based services to the benefit of the State of Bihar
- Overseeing the orderly development and consolidation of MMC's institutional capacity, including its human resources and knowledge base
- Selecting from itself, members of the SRC which shall review and approve the deliverables of the Managing Consultant.
- Selecting from itself, members who will form the core team(sub-committee) of BOT that can meet at very short notice for discussing issues which will require immediate solutions including quick budget requirements as calculated and recommended by Managing Consultant and approved by the Managing Director of COE for the hitch-free sustainable maintenance (Section 1.5) of the MMC. This sub-committee should be headed by the Managing Director of the COE.
- Providing guidance on immediate and potential future demands of services from MMC
- Providing support to the dialogue and collaboration between MMC and its service users (Initially only WRD, Bihar), sister institutions, and the academic community

- Approving reforms related to the management structure, budget and general running strategies of MMC based on accepted (by SRC) quarterly review reports prepared by the Managing Consultant.
- Assessing need for and approving additional consultancy requirements for specific modelling or other tasks.

The Managing Director of COE

- Serving as the Member Secretary of the BOT
- Being responsible for calling meetings of the core BOT, the whole BOT and the SRC whenever required, while adhering to the direction given by the Chairman and Vice- Chairman of the Board
- Monitoring the work of the Managing consultant and working with them to monitor the staff of MMC

Taking care of day-to-day operation and management of the MMC including allocation of human and financial resources

- Liaising closely the activities of the FMISC, MMC and PMC by doing so between their respective Directors.
- Guiding and approving policies for outreach programs such as publishing achievement reports and papers of studies and financial statements.
- Having over-all responsibility, jointly with involved specialists from the team of Managing Consultants and the Director MMC, for liaison and good external relations (with service users and partner institutions, including the academic community)
- Pursuing institutional networking, outreach and visibility in various ways, aiming at recognition and confidence from actual and potential service users in Bihar and beyond

The Director MMC

- Reporting to the Director of COE for the day-to-day operation and management, including allocation of human and financial resources
- Liaising closely with the FMISC Head, Team leader of Managing Consultant and PMC Head (when it gets established) for smooth functioning towards achievement of common goals.
- Being responsible for a service-oriented and demand-responsive corporate culture in the MMC with skilled, motivated and dedicated staff, and divisions and units that

interact pro-actively and support each other by sharing knowledge and resources according to needs

- Having over-all responsibility, jointly with involved specialists from the team of Managing Consultants and the Heads of the Divisions of MMC, for the scientific quality of the services, their timely delivery of the reports, and appropriate communication to the service users of recommendations and suggestions, along with related assumptions and uncertainties
- Interacting with the BOT through the Director of COE about strategic directions for medium- and long-term development of the MMC
- Pursuing broad dissemination of MMC's expertise, expectedly involving thematic seminars/roundtables, newsletters, papers and monographs

Directly heading the Facilities Management of the MMC and also training programs, both internal and external.

1.2.2 MAIN WORKING BODY OF MMC

The structure of the main working body of MMC is closely related to the work it will undertake and how that work will grow and diversify over the first three years. The physical infrastructure needs would also increase with the work load of the centre in Phase II.

Divisions and Units

Figure 1-3 shows the Organisation chart for the main body MMC in Phase I. There will be six units in the MMC in the Phase I, namely:

River Basin & Flood Modelling Unit

RS-GIS & Data Unit

Sedimentation & River Engineering Unit

Field Survey and Laboratory Unit

Facilities Management Unit

Training Unit

The River Basin & Flood modelling and RS-GIS & Data Units will be under the “**River Basin Management**” Division which will be headed by a Head of Division.

The Field survey & Laboratory and the Sedimentation & River Engineering Units will be under the “**Engineering investigation**” Division, which will also be headed by a Head of Division.

In Phase II, an additional unit, “Water Resources Systems and Irrigation Unit” will be added under the River Basin Management Division. Another major change in this division will be a separate “DSS Unit” for DSS development activities which in Phase I was included in the GIS & Data Unit. Another additional unit for public awareness & Media relations will be monitored by the Head of MMC in Phase II. Note that the additional units in Phase II are tentative at this stage and this will need to be revised towards the end of Phase I. **Figure** shows the Organisation chart for the MMC in Phase II. It is also recommended that beyond Phase II, a unit for Environmental and Climate Change also be exclusively included in the MMC.

Roles and Responsibilities of Divisions and their Heads while starting out

Both Divisions will work in coordination to meet the tasks planned for the MMC in the respective Phase under the supervision of the Heads of Divisions whose main responsibility will be to provide quality control and timely outputs from their respective divisions and also coordinate with each other to facilitate smooth transfer of information and jobs between the divisions whenever needed.

Both the Heads of Divisions will be answerable to the Head of the MMC. Their main responsibilities will include coordination with each other for inter-divisional work flow, quality control of the individual and combined outputs by coordinating with the experts from the team of Managing Consultant. The training unit will be directly headed by the MMC Head with guidance from the managing consultant.

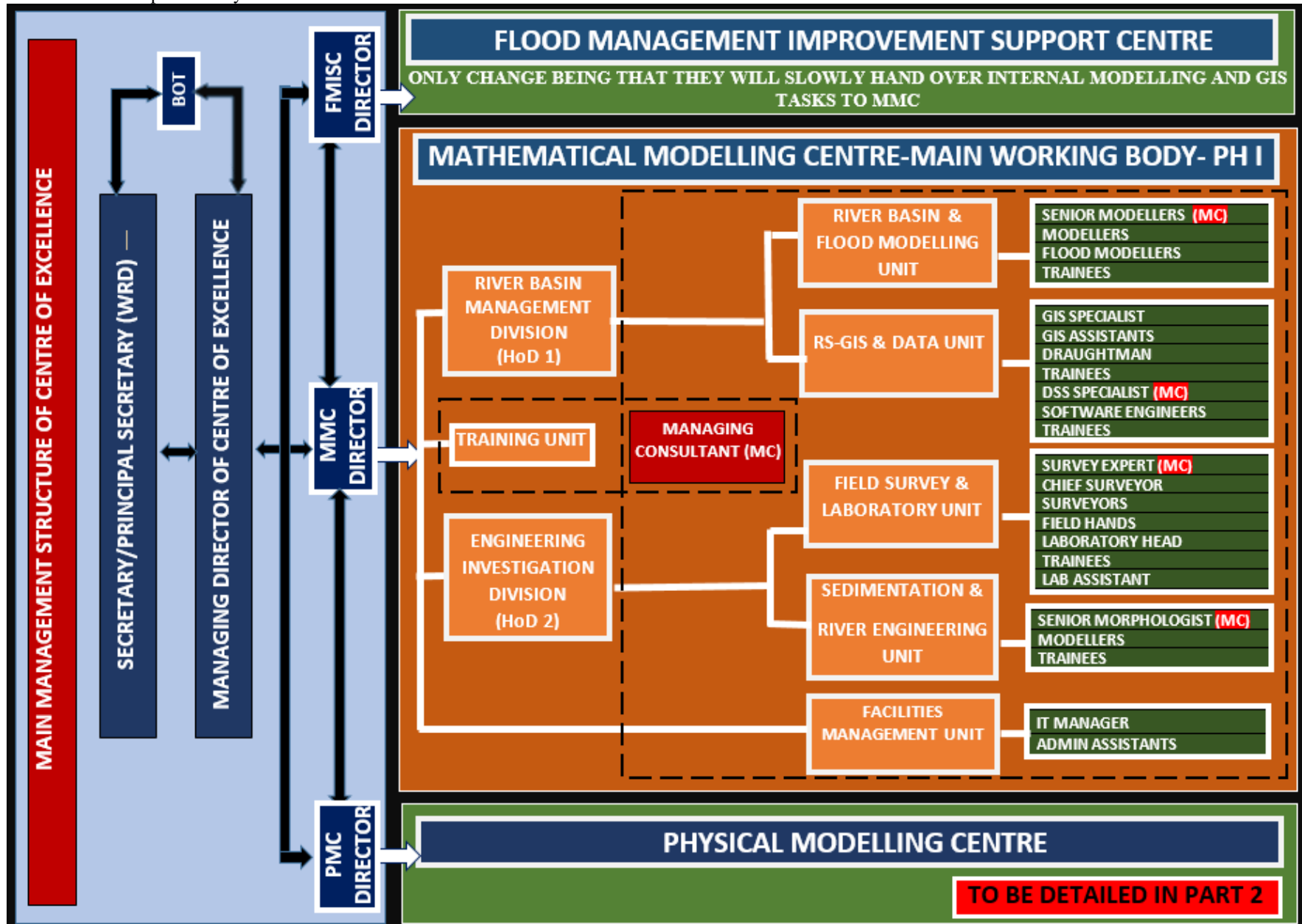


Figure 3- Organisation Chart for MMC Phase I

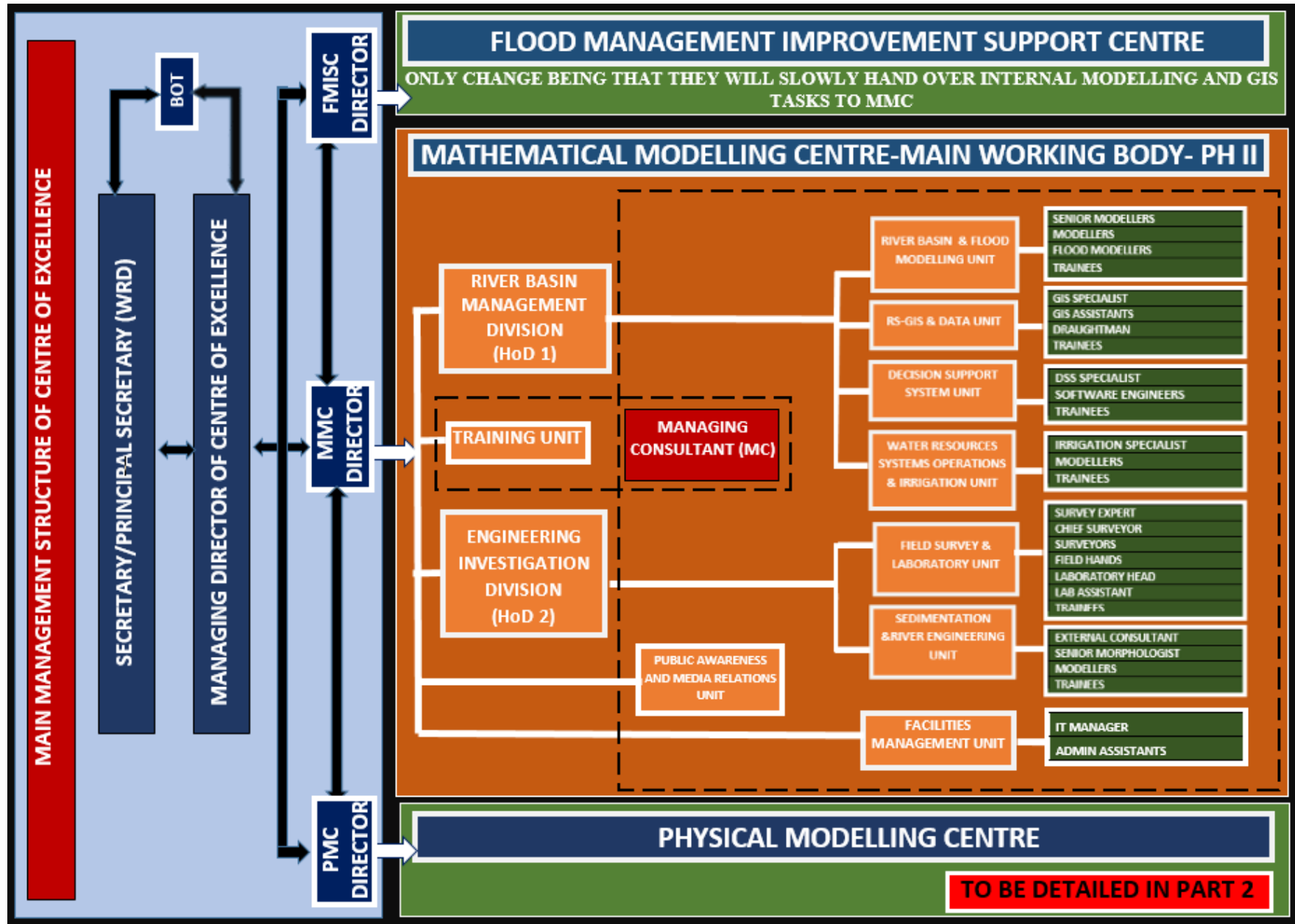


Figure 4- Organisation Chart for MMC Phase II- Tentative

Unit wise Roles and Responsibilities

The following units of the MMC will be responsible for maintaining the 4 domains of the MMC:

River Basin & Flood Modelling Unit: This unit would handle all types of modelling dealing with hydrology and basin wide water balances. The hydrological models with lumped parameter and more detailed distributed parameters will be developed and maintained in this unit. One-dimensional river network models and flood models will also be within the purview of this unit. The river network models – which can be made to cover the entire area of interest would provide the framework for every type of detailed sub-model simulating hydrodynamic processes and other related phenomena such as sediment transport and transport of pollutants. These models have the possibility of faster run times and very long simulation periods. This unit will maintain a “Regional Model” that would cover all the river basins in Bihar that could be used for providing boundary conditions to any hydrodynamic sub-model created for a particular study. In order that the model in effective a significant reach of the Ganges would have to be included in the model. This unit will also initiate and supervise specific field measurement programmes. Training of staff will be a major internal activity

RS-GIS and Data Unit: This unit would be based on the data accumulated by the existing GIS unit of FMISC. The database will be further expanded when necessary to accommodate other types of data gathered by MMC and other projects. The data would be geo-referenced and included in the GIS – and accessible to all workers at MMC. Satellite images will be included and specific activities such as mapping the evolution of river bank lines would provide essential information to the Sedimentation and River Engineering Unit. The GIS & Data Unit will create links with the K-EAMS database (which is also geo-referenced) and other Data from the envisaged “Data Centre” so that all the available data is linked directly to MMC modelling units. The time series data created for model input and time series data arising for model outputs would also be stored in the GIS Database in the appropriate data formats. Conversion of data from GIS to and from model formats would also be a regular function of this unit. River cross data and DEM data would also be incorporated in the database. The elements of Decision Support Systems will be introduced to the staff before the close of Phase 1.

Sedimentation and River Engineering Unit: Sedimentation has been included within the ambit of the River Engineering Unit because of the very close relationship between sedimentation processes and the frequently needed engineering designs aimed at flood

management and maintenance of infrastructure. Sediment transport modelling will be principally done by this unit. The 1-Dimensional Morphological models would be schematised, set up, calibrated and maintained for estimating broad sedimentation rates and for providing inputs to the detailed 2-Dimensional morphological models. The long 2-Dimensional models developed by the Master Plan project would be absorbed, further developed and refined. More detailed models will be created for specific reaches of the river that need to be investigated for developing proposals and designs for flood management infrastructure, or for investigating failure mechanisms. The modelling teams would be working closely with the WRD designs and monitoring units so that design parameters are determined collectively and the modellers receive feedback from the designers. This unit will also be closely involved with the field survey unit and the sediment laboratory.

Water Resources Systems Operations & Irrigation Unit: This unit will be formed in the Phase II of the MMC and will work with Multi-objective planning and modelling tools to study the Water Resources Systems. The various areas of study in this unit will include Reservoir Planning with Multi-purpose Multi-reservoir operations, optimization studies, Irrigation scheduling studies including groundwater component and Ground Water Resource Planning.

At a later stage, the unit will also study Water Quality Issues.

DSS Unit: This unit will be formed in the Phase II of the MMC and in addition to some new responsibilities, will take over some responsibilities of the GIS & Data Unit.

The other section of this unit will be responsible for database management, DSS, Dissemination Systems and Dashboard Management.

Field Survey and Laboratory Unit (Later to be moved to PMC): In addition to collecting project specific data and supervising large data collection programmes, the field survey unit would introduce the modellers to field conditions and the way measurements are actually made in the field, their strengths and their weaknesses. A full appreciation of the accuracy of measurements and the meaningfulness of model schematization would assist the modelling process. Sediment sampling (both suspended sediments and bed material) is an important aspect. The field data will be interpreted to determine the parameters to be used in the sediment transport model. Particular care will be taken in interpreting data to derive sediment rating curves.

Having a reliable Digital Elevation Model (DEM) essential for preparing a good flood inundation model. While the bathymetry of river channels could be surveyed easily with echo-sounding, the very broad flood plains are very laborious and time-consuming to survey. An aerial LiDAR survey could achieve this more easily. It would thus be necessary for the Field Survey unit to supervise this work closely and to ensure that ground truthing is done well.

Training unit: The training unit would work with every unit in the Centre and together with the Managing Consultant's team to coordinate all training activities (refer section 1.7)

Facilities Management Unit: This unit will be responsible for all the IT/IS at MMC and also manage other building facilities. The IT manager would coordinate with the supplier/installer for the regular upgradation and maintenance procedures. The unit will also be responsible for the sustainable maintenance of the MMC. (Refer section 1.5)

Public Awareness & Media Relations Unit: This unit is proposed for Phase II directly headed by the MMC Head. It is recommended that selected members from the MMC across the Divisions and Units directly by the MMC Head be a part of this Unit. In addition to their other technical duties, the unit members will strive towards publishing papers of studies carried out at MMC and actively participate in other outreach programs.

1.3 STAFFING

1.3.1 Phase-wise staffing requirement

Table 1 -Staffing Requirements & Qualifications

	POSITION	MINIMUM QUALIFICATIONS	SPECIALITY	EXPERIENCE (YEARS)	NO. OF POSTS		DUTIES
					PH. 1	PH.2	
RIVER BASIN & FLOOD MODELLING UNIT	SENIOR MODELLER	MASTERS	WATER RESOURCES/ HYDRAULICS/ HYDROLOGY/MODELLING	15	1	1	MANAGEMENT, WORK ALLOCATION, QUALITY CONTROL
	FLOOD MODELLER	MASTERS OR BACHELORS WITH TRAINING	WATER RESOURCES/ HYDRAULICS/ HYDROLOGY	5	2	2	DATA PROCESSING, FIELD WORK, MODEL BUILDING MODEL RUNNING, REPORTING
	JUNIOR MODELLER	MASTERS OR BACHELORS WITH TRAINING	WATER RESOURCES/ HYDRAULICS/ HYDROLOGY	5	1	2	DATA PROCESSING, FIELD WORK, MODEL BUILDING MODEL RUNNING, REPORTING
	TRAINEE MODELLER	BACHELORS	CIVIL ENGINEERING	0	1	2	FIELD WORK, DATA ENTRY & PROCESSING, ON-THE-JOB TRAINING ON MODEL SETTING UP AND RUNNING
SEDIMENTATION & RIVER ENGINEERING UNIT	SENIOR MORPHOLOGIST	MASTERS	WATER RESOURCES/ HYDRAULICS/ SEDIMENT TRANSPORT/HYDROLOGY/ MODELLING	15	1	1	MANAGEMENT, WORK ALLOCATION, QUALITY CONTROL EXPERT ADVICE TO TEAM
	RIVER ENGINEER	MASTERS OR BACHELORS WITH TRAINING	HYDRAULICS/ SEDIMENT TRANSPORT/HYDROLOGY/E XPERIENCE IN PLANNING, DESIGNING, EXECUTION OF BANK PROTECTION/ANTI-EROSION WORKS IN KOSI BASIN	5	1	2	DATA PROCESSING, FIELD WORK, MODEL BUILDING MODEL RUNNING, REPORTING
	JUNIOR MODELLER	MASTERS OR BACHELORS WITH TRAINING	HYDRAULICS/ SEDIMENT TRANSPORT/HYDROLOGY	5	1	2	DATA PROCESSING, FIELD WORK, MODEL BUILDING MODEL RUNNING, REPORTING
	TRAINEE MODELLER	BACHELORS	CIVIL ENGINEERING	0	1	2	FIELD WORK, LABORATORY WORK, ON-THE-JOB TRAINING ON MODEL SETTING UP AND RUNNING

	POSITION	MINIMUM QUALIFICATIONS	SPECIALITY	EXPERIENCE (YEARS)	NO. OF POSTS		DUTIES
					PH. 1	PH.2	
RS-GIS AND DATA UNIT	RS- GIS SPECIALIST	MSC/MA IN AREAS OF GEOSCIENCES	GIS/ REMOTE SENSING	15	1	1	MANAGEMENT, WORK ALLOCATION, QUALITY CONTROL EXPERT ADVICE TO TEAM
	RS-GIS ASSISTANT	MASTERS OR BACHELORS WITH TRAINING	ENGINEERING/SCIENCE	5	1	4	DATA PROCESSING, DATABASE MANAGEMENT, DEM DEVELOPMENT REPORTING
	SOFTWARE ENGINEER	MASTERS OR BACHELORS WITH TRAINING	IT /SOFTWARE DEVELOPMENT	5	1	0	DATA PROCESSING, BUILDING DSS SYSTEM TESTING DSS, REPORTING
	DSS SPECIALIST	MASTERS OR BACHELORS WITH TRAINING	MUST HAVE VAST EXPERIENCE IN SETTING UP DSS FOR OTHER PROJECTS	15	1	0	MANAGEMENT, WORK ALLOCATION, QUALITY CONTROL EXPERT ADVICE TO TEAM
	DRAUGHTSMAN	MUST BE PROFICIENT IN AUTOCAD, CIVIL ENGINEERING DRAWINGS, MAKING BOQ etc.		3-5	1	1	TO PREPARE ENGINEERING DRAWINGS, AND OTHER DRAWINGS & RELEVANT DOCUMENTS.
	TRAINEES	BACHELORS	ENGINEERING/SCIENCE	0	2	2	FIELD WORK, LABORATORY WORK, ON-THE-JOB TRAINING ON MODEL SETTING UP AND RUNNING
FIELD SURVEYS & LABORATORY	CHIEF SURVEYOR	BACHELORS WITH PROFESSIONAL QUAL.	SURVEYING/ HYDROGRAPHY	15	1	1	MANAGEMENT, WORK ALLOCATION, FIELD SUPERVISION, QUALITY CONTROL EXPERT ADVICE TO TEAM
	SURVEYOR	MASTERS OR BACHELORS WITH TRAINING	SURVEYING /ENGINEERING/SCIENCE	5	1	4	RIVER SURVEY, RIVER GAUGING, DATA PROCESSING, FLOW MEASUREMENT, SUPERVISE EXT SURVEYS
	FIELD MEASUREMENT ENGINEER	MASTERS OR BACHELORS WITH TRAINING	WATER RESOURCES/ HYDRAULICS/HYDROLOGY/ SCIENCE	5	0*	1	RIVER SURVEY, RIVER GAUGING, DATA PROCESSING, FLOW MEASUREMENT
	TRAINEES	BACHELORS	ENGINEERING/SCIENCE	0	0**	2	FIELD WORK, RIVER SURVEY, ON-THE-JOB TRAINING ON DISCHARGE MEASUREMENTS AND SAMPLING
	TECHNICIAN	DIPLOMA	INSTRUMENTATION / ELECTRONICS	5	1	1	MAINTENANCE OF INSTRUMENTS / EQUIPMENT

	POSITION	MINIMUM QUALIFICATIONS	SPECIALITY	EXPERIENCE (YEARS)	NO. OF POSTS		DUTIES
					PH. 1	PH.2	
WATER RESOURCES SYSTEMS & IRRIGATION UNIT	IRRIGATION SPECIALISTS	MASTERS OR BACHELORS WITH TRAINING	WATER RESOURCES/ HYDRAULICS/HYDROLOGY/ SCIENCE/ IRRIGATION/MODELLING	5	0	1	MANAGEMENT, WORK ALLOCATION, QUALITY CONTROL, EXPERT ADVICE TO TEAM, COORDINATION WITH DSS
	MODELLER	MASTERS OR BACHELORS WITH TRAINING	HYDRAULICS/HYDROLOGY	5	0	1	DATA PROCESSING, MODEL RUNNING, SUPPORTING DSS BUILDING, REPORTING
	TRAINEES	BACHELORS	IT/ WATER RESOURCES/ HYDRAULICS/ HYDROLOGY	0	0	2	ON-THE-JOB TRAINING ON MODEL SETTING UP AND DSS OPERATION
DECISION SUPPORT SYSTEM UNIT	DSS SPECIALIST	BACHELORS WITH PROFESSIONAL QUAL.	SURVEYING/ HYDROGRAPHY	15	0	1	MANAGEMENT, WORK ALLOCATION, FIELD SUPERVISION, QUALITY CONTROL EXPERT ADVICE TO TEAM
	SOFTWARE ENGINEER	MASTERS OR BACHELORS WITH TRAINING	IT /SOFTWARE DEVELOPMENT	5	0	2	DATA PROCESSING, BUILDING DSS SYSTEM TESTING DSS, REPORTING
	TRAINEES	BACHELORS	ENGINEERING/SCIENCE	0	0	2	ON THE JOB TRAINING
COMPUTER SYSTEM	SYSTEM MANAGER	BACHELORS WITH PROFESSIONAL QUAL.	DOMAIN ADMINISTRATION, ANTI-VIRUS MANAGEMENT, HARDWARE MAINTENANCE, POSTGRESQL DATABASES	5	1	1	SUPPORT, MONITOR, TEST & TROUBLESHOOT HARDWARE& SOFTWARE PROBLEMS. BE RESPONSIBLE FOR MANAGING THE IT SYSTEM TO MEET STRATEGIC GOALS. BE RESPONSIBLE FOR ENSURING AVAILABILITY & PERFORMANCE OF THE DATABASES THAT SUPPORT THE SYSTEM. TO ENSURE ENDURANCE OF THE ASSOCIATED HARDWARE RESOURCES ALLOCATED TO THE DATABASES. ADMINISTRATION OF SERVERS & MAINTAIN & SUPPORT LAN/WAN ENVIRONMENT.
	ADMIN ASSISTANT	GRADUATE			1	1	ADMIN OF INSTRUMENTS / EQUIPMENT/ BUILDING/ TRAVEL/TRAININGS etc. & ALSO MUST SIT AT FRONT DESK

. * In Phase I, the River Engineer from the Sedimentation & River Engineering Unit will fill in for the post

** In Phase I, the Trainees from the all other Units will fill in for the post

1.3.2 Staff Selection and Rotation Process

- The proposed rank of the Director of COE is Chief Engineer. He/she must have sharp management skills and prolonged exposure to hydraulic modelling projects. The role of this post will be mainly administrative.
- The proposed rank of the Heads of FMISC, MMC and PMC (when it gets established) is Superintending Engineer. This person should also have sharp management skills and prolonged exposure to hydraulic modelling projects. The role of these posts will be mainly administrative but the candidate must be in a position to understand technical aspects in order to facilitate major technical decisions.
- The proposed rank for the Heads of Divisions in the MMC is Executive Engineer having sharp management skills and prolonged exposure to hydraulic modelling projects. The role of these posts will be administrative and also technical to an equal magnitude.
- For the rest of the staff, a standard methodology has to be adopted for assigning the right people for the posts in the MMC. Firstly, eligible and interested officers from the existing pool of experts at WRD-Bihar/ FMISC have to be recognised for appropriate posts. The remaining posts must be filled by engineers/modellers on a contract basis with a renewal period of about 30 months (initially for Phase I) which may extend up to 5 years in later stages of MMC. It is important to adhere to the qualification requirements and also to the minimum stipulated experience for all the positions.

If the directly recruited staff are to be paid a higher rate of pay than those in the Division, it would be advisable to pay an additional allowance to Divisional Staff during the period they serve at MMC.

- In Phase I, it is recommended that counterpart staff for the posts of senior modeller, morphologist, DSS Specialist and the Chief Surveyor be from the team of Managing Consultant appointed. A needs based decision towards the end of Phase I may be taken to retain and reappoint a part of this team for continued process for stabilisation.
- In addition to satisfying the minimum written qualifications, the staff of the Modelling Centre must be able to demonstrate a commitment and interest in carrying out modelling and the related field work which will become a reality in the day to day life at MMC. The staff recruited from the FMISC/WRD as modellers should be given the option (say towards the end of the Phase I) whether to continue

in their new career or to return to normal duties in the Division or in FMISC. The offer to stay in MMC would be based on an assessment carried out internally. Those who return to their regular job would hopefully retain a better feel for the new modelling technology and its place in the work of the division.

The staff posted in MMC and recruited for MMC should be given incentive with additional allowances, priority in allotment of Government Accommodation etc.

The sustainability (or even the survival) of the Centre would depend retaining the services of key staff for a long period of time. While it might be beneficial for FMISC/WRD to rotate a number of government staff members through MMC (say on a two year rotation) to familiarise themselves with the technology being used to serve the division, it is even more important that the skills learned at MMC should not be dispersed until they are institutionalised within MMC. It is essential that Key Staff are allowed serve MMC for long periods – or even give up their service in WRD and take up permanent posts at MMC. The administrative arrangements for this would be left to the discretion of the WRD, Bihar.

1.4 BUILDING/ SPACE IDENTIFICATION

After much deliberation and discussion with the stakeholders, there is no suitable building immediately available which will be able to house the eventually envisaged capacity of the MMC. However, the FMISC/WRD has provided sufficient floor space that can serve the projected capacity of MMC during Phase I.

At the end of Phase I, if required, a new Building/Space will need to be identified for accommodating the extended capacity of the MMC. In this case, the entire MMC (computer systems, peripherals, laboratories etc. will need to be moved and additional facilities will need to be created.

The location identified for the Phase I of the MMC is the current site of the FMISC, i.e. 2nd Floor Jal Sansadhan Bhawan, Anisabad, Patna

It has been agreed that a part of the FMISC's existing space (in Block A) with added space on the same floor in the adjoining building (Block B) which is also owned by the WRD will be utilised.

The selected office space for M.M.C is on 2nd floor. The total carpet areas is:

Block A :	59.00 sqm
Block B :	192.00 sqm
Corridor :	16.00 sqm

Total : 267.00 sqm

The space occupied by the MMC in the current FMISC office will be limited to their GIS section and Lunch room. **The following rooms/spaces have been designed for the Phase I of MMC:**

- Common Server Room
- GIS-Workstation Room
- Training and Modelling Room
- UPS Room
- Lunch/Dining Room
- MMC Head's Room
- Room for HODs
- Store Room
- Sediment Laboratory

Out of the two entrances given to the MMC, the main one will be adjacent to the existing FMISC. The door separating the two centres will have a punch card sensor. It is proposed to have the admin staff of the MMC seated at the welcoming area. Half of the existing GIS Room of FMISC (currently) is to be converted to a combined server room for the MMC and the proposed Data Centre.

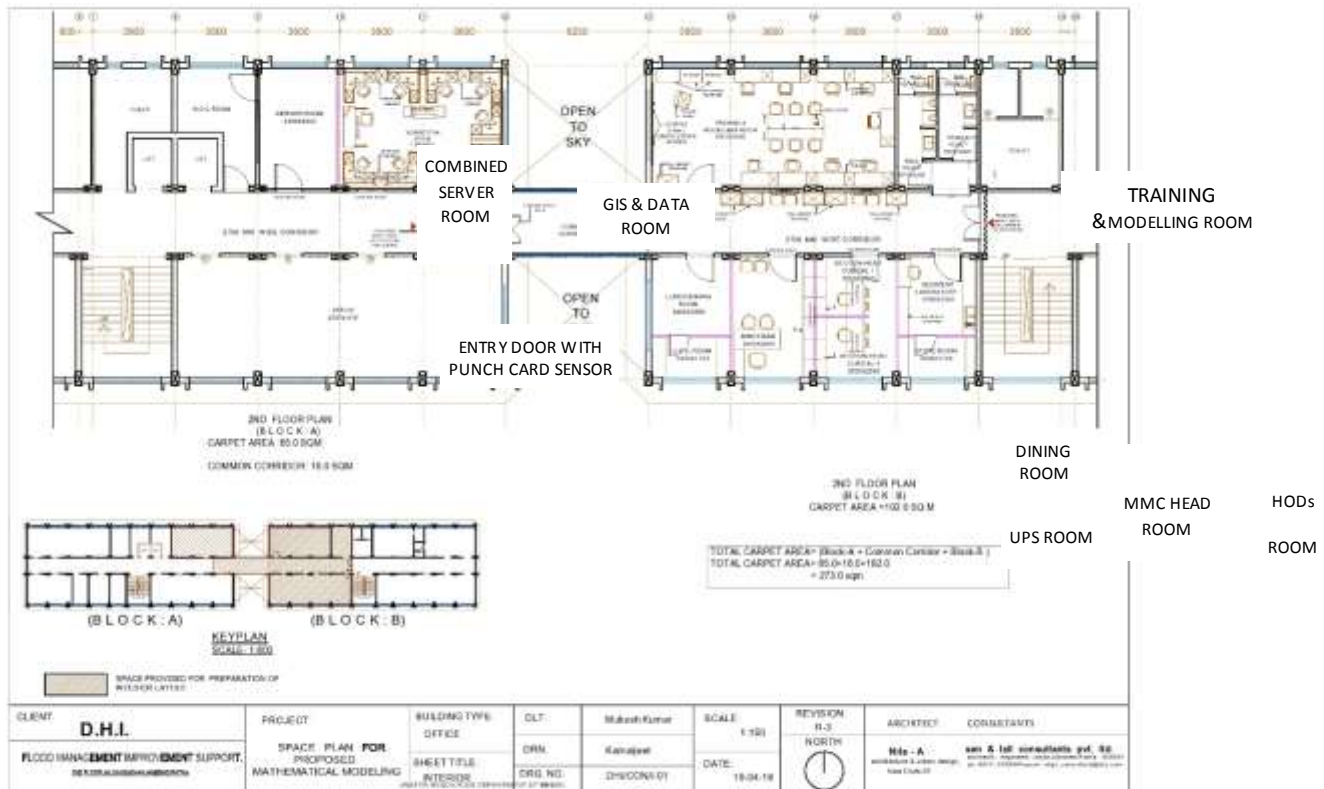
The GIS section of the MMC will be of the same size as it was in FMISC by combining half of the current GIS Room of FMISC and its Lunch Room and will have seating arrangements for seven staff members from the "GIS & Data" Unit and also the IT Manager from the "Facilities Management" Unit. The rest of the spaces designed for the MMC will be in Block B to access which, the corridor connecting the two blocks will have to be crossed. A water cooler is proposed to be placed in this corridor. The Training & Modelling room in Block B will be as big as the common server room and GIS room combined. This room will have seating arrangements for the 9 modellers of the "River Basin & Flood Modelling" Unit and the "Sedimentation & River Engineering" Unit. All the formal in-house trainings will be conducted in this room and the provision for the same has been recommended including display screens, pull down screen and projector system.

All the seating arrangements have been designed to have their individual storage units and there are additional storage units of appropriate sizes proposed at various locations in the MMC.

A room of the same dimensions as the Joint Director's Room has been designed for the Head of MMC and another similar room is designed to have 2 sections, one for each Head of Division.

A sediment lab has been designed with an adjoining store room for lab equipment. The room for UPS has been designed to be at the space with least risk relative to people and property. A dining space has also been included in the design at a location in Block-B which is nearest to Block A. Separated Ladies and Gents Toilets have been

Terms of Reference



Indicative Plan for MMC - Phase I

1.5 SUSTAINABLE MAINTANANCE

The Centre will be expected to deliver many of its services according to fixed submission schedules, and undue delays should be avoided to the extent possible. This requires (among other things) orderly and sustainable maintenance across the different assets and facilities, in the period when funding is available, and also once the Centre has become financially self-sustainable.

This includes building maintenance; lab equipment upgrading & maintenance; IT/ IS (hardware and software) maintenance; and software upgrading and maintenance.

Three categories of maintenance are needed:

- Preventive maintenance: Regular check-ups, upgrades and proper maintenance of records.
- Corrective maintenance: Immediate repair or replacement of broken or damaged items.
- Adaptive maintenance: Keeping 'state-of-the art' tools and facilities updated in order to retain their relevance and optimal performance relative to evolving standards and expectations.

Initially, maintenance will be facilitated by detailed documentation (specifications, drawings, etc. as hardcopies and softcopies). Guidelines and check lists will be developed gradually, capturing needs and modalities.

The responsibility for maintenance should lie with the “Facilities Management” Unit, to be placed directly under the Head of the MMC. A dedicated allocation must be made in the annual budget for maintenance and replacements. For the IT facilities, the costs must be included in the maintenance contract signed with the provider/installer.

1.6 WORK PLAN

1.6.1 Pre Phase I

The following tasks are to be completed by the FMISC, WRD, Bihar, before the starting of Phase I. A period of 6 to 8 months is recommended as time within which these must be completed.

To finalise building/space to be converted and equipped with the amenities with sufficient floor area to house the staff (as recommended), equipment and laboratory facilities necessary for MMC in Phase I as recommended in the DPR.

To finalise the budget & funding for Phase I and a tentative one for Phase II.

To procure chosen modelling/processing/GIS software for the MMC within the first month.

To identify and employ the staff for the posts in the Main Management Structure

- Director of COE
- Members of BOT
- Joint Director of FMISC; provided it is decided by the Principal Secretary, WRD, Bihar, that the Current JD is to be promoted to Director of COE
- Heads of Divisions of MMC

To identify the Managing consultant for the MMC and employ their services with the start of Phase I.

To identify the contractors for renovation of identified building/space.

To start bidding procedure for identifying source for procurement of IT hardware & software, two months before Phase I starts so that the order for the items may be placed by the third month of the Phase.

- To start bidding procedure for identifying source for lab equipment, two months before Phase I starts so that the order for the items may be placed by the third month of the Phase

1.6.2 Phase I

The work plan for Phase I is based on the need to provide basic training to the staff while at the same time providing the modelling outputs for the Client (WRD) and for other, more advanced models that need to be run.

Operations would be as indicated in the Table below:

Table 1 - Tasks for Phase I

TASK NO.	TASK	RESPONSIBLE PARTY/DEPARTMETNS/UNITS
1	MMC STAFF RECRUITMENT	DIRECTOR OF COE/ FMISC, WRD,BIHAR/HEADS OF DIVISIONSS
2	BUILDING RENOVATION	APPOINTED CONTRACTOR
3	IT/IS ORDERING	DIRECTOR OF COE/ FMISC, WRD,BIHAR
4	IT/IS DELIVERY & INSTALLATION	APPOINTED SUPPLIER
5	SEDIMENT LAB EQUIPMENT ORDERING	DIRECTOR OF COE/ FMISC, WRD,BIHAR
6	DELIVERY OF SEDIMENT EQUIPMENT & SETUP OF LAB	APPOINTED SUPPLIER
7	FEILD EQIPMENT DELIVERY	APPOINTED SUPPLIER
8	RIVER GAUGING EQUIPMENT TESTING	SURVEY EXPERT(MC)/FIELD SURVEY UNIT

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9	AQUIRING ALL HISTORICAL DATA (WRD, CWC, ETC)	HODs/DSS SPECIALISTS(MC)/ GIS & DATA UNIT
10	SETTING UP INITIAL DAS AND DATABASE**	HODs/DSS SPECIALISTS(MC)/ SPECIALISTS FROM MODELLING UNITS(MC)/GIS & DATA UNIT/
11	HISTORICAL DATA ANALYSIS**	SPECIALISTS FROM MODELLING UNITS(MC)/ LOCAL TEAM FROM MODELLING UNITS
12	EXISTING MODEL REFINING & TRANSFERS**	SPECIALISTS FROM MODELLING UNITS(MC)/ LOCAL TEAM FROM MODELLING UNITS
13	SETTING UP INITIAL 1D MODEL- INTEGRATED BASINS OF BIHAR**	SPECIALISTS FROM MODELLING UNITS(MC)/ LOCAL TEAM FROM MODELLING UNITS
14	SETTING UP INITIAL 2D MODELS**	SPECIALISTS FROM MODELLING UNITS(MC)/ LOCAL TEAM FROM MODELLING UNITS
15	1D BASIC TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
16	1D REFRESHER TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
17	1D ADVANCED TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
18	2D BASIC TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
19	2D REFRESHER TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
20	2D ADVANCED TRAINING	MMC HEAD/ HODs/ MANAGING CONSULTANT
21	PHASE II PLANNING	BOT/DIRECTOR OF COE/ FMISC,MMC, PMC(if it is established) HEADS/ MANAGING CONSULTANT

Intermittent input from various experts as per requirement and gradual withdrawal

** These activities go hand in hand with the on-the-job training

Task 1: At least 70% of the staff of MMC, (either from WRD or people specially hired on contract) must be employed before the end of first 3 months from the start of Phase I. Refer section 1.3 for details on staffing.

Task 2: The contractor appointed to carry out the recommended renovation works must complete the process within the first 3 months of the Phase I under supervision of representative chosen from FMISC, WRD Bihar.

Task 3 to Task 7: Respective appointed suppliers under supervision of representative chosen from FMISC, WRD, Bihar and Managing Consultant. Training to be given by the supplier for the IT hardware and other Equipment should be scheduled by the concerned HOD's.

Task 8: The River gauging equipment that need testing will have to be tested at appropriate locations by a team from the Field Survey Unit lead by the Survey Expert (MC).

Note that this team will also be responsible to support modelling teams with activities for supporting model calibration and validation, Commissioning of LIDAR survey and other relevant field surveys for the MMC also for the setting up of PMC based upon availability of staff and requirement of WRD, Bihar.

Task 9 & Task 10: The Database at MMC is to be linked dynamically with the Data Centre (when established), K-EAMS, BA-EAMS and well as the various other field data acquisition systems for other basins of Bihar and Ganges Basin, developed within WRD, Bihar and also other Organisations. The Data must include the following:

Telemetry Data

IMD Data

Forecast Data: Rainfall and Temperature

Snow Data

Topographical data (LiDAR, SRTM etc.)

Satellite Data- Precipitation, land use etc.

Manually observed & surveyed Data: Flows, Water-Levels, Sediment, Cross-section data etc., Hydrometric data from WRD, CWC etc., Demographic Data

These tasks must be carried out by the GIS & Data Unit under direction from the DSS Specialist and the Modelling Experts from the team of MC.

Task 11 to 13: This task has to be carried out by the modelling teams lead by the Modelling Experts under guidance from the HOD's. Note here that initially, emphasis has to be given to the Kosi Basin and Bagmati.

The modelling tasks must include River Basin & Flood Modelling: Hydrological Modelling, River Network Modelling, Inundation Modelling, and Flood Forecasting.

Task 14: This task has to be carried out by the flood & sediment modellers from the River Basin & Flood Modelling unit and the Sedimentation & River Engineering unit led by the Modelling Experts under guidance from the HOD's. Note here that again, emphasis has to be given to the Kosi Basin and Bagmati while starting out.

The studies must include Sediment Transport Modelling, Morphology, River Bank Erosion and Protection Works, Design Support and also Intervention Impact assessment analysis.

Task 15 to 20: A separate training unit will be set up directly under the MMC Head with assistance from the Managing Consultant. This unit will coordinate all training activities including formal training course conducted in-house, off Campus and overseas. On-the job training will be the responsibility of the individual units.

Task 21: Based on the following deliverables submitted by the MC and approved by the SRC, a revised plan for Phase II will need to be approved by the Principal Secretary, WRD BIHAR, BOT, Director of COE, and all other relevant members of Main Management:

- Progress Reports at 3 monthly intervals – Progress of work and schedule of deadlines met, and recommendations for improving performance
- Interim Report after 12 months outlining the work done in the previous 12 months and making appropriate recommendations including a management plan and institutional structure for the future MMC and a full review of the existing software make recommendation for future acquisitions, and provide a revised expert deployment plan with justification.
- Draft Final Report after 18 months making a full assessment of the success of the consultancy so far and making recommendations for the continuation or otherwise of the assignment – including a full report of the consultation with Joint Director of FMISC, Head of MMC and donor representative regarding the Consultant's performance. This report will also pay special attention

1.6.3 Phase II

Some of the activities, roles and responsibilities will be distributed among other new units when the organisation is expanded in Phase II.

The existing modelling units from Phase I must keep working **on improving the models already setup** and also **venture into new modelling tasks** to cover even more basins of Bihar. They must try to **consolidate all their skills developed** in the previous phase and also start **to train new recruits**, thereby building their confidence. Also, they must be more involved with the design teams of WRD to support the state of Bihar more efficiently.

It is proposed at this stage that at least 3 new Units, “Water Resources Systems and Irrigation Unit”, a separate “DSS Unit” and a unit for “Public Awareness & Media relations” be added to the MMC. Note here that these are tentative and that there may be more or less number of units decided for Phase II depending upon the evaluation of the progress of the MMC in the previous Phase and also upon the need assessment.

The main tasks proposed for the Water Resources Systems and Irrigation Unit in Phase II are:

- Carrying out the efficiency analysis, issues and capacity studies for the canal systems of Bihar,
- Studies to identify efficient cropping patterns and also
- Carrying out investigative studies to determine solutions to the issues related to the state’s water resources and their optimum utilisation.

The main tasks proposed for the DSS Unit in Phase II are:

- Taking over the DSS development activities which in the Phase I was included in the GIS & Data Unit
- Increasing the capacity of the MMC for developing DSS by training new recruits.
- Creating DSS for the already established models during Phase I.

The main tasks proposed for the Public Awareness & Media relations Unit in Phase II are:

- Setting up a website for the MMC to publish information, papers related to the Studies carried out and news from the MMC for Information Dissemination.
- Organising conferences and other such outreach programs in Bihar and other states promoting the work being done at the MMC and also to create Public awareness and
- Carrying out Sociological Surveys, Stakeholder Consultations, Public Relations activities etc.

Other operations of Phase II would comprise the following:

Field investigations and Surveys: for carrying out specific (usually detailed) field investigations in support of studies conducted by the Centre and to add to the existing database. This unit will also have under it the Sediment Analysis Laboratory. *This unit*

will be transferred to PMC Birpur as soon as it is practical to do so where it will be extended to include a Quality Control lab for testing materials used in relevant construction such as protection works and also for the materials used for the physical models at the PMC.

GIS and Data: for acquiring and storing data in a networked, geo-referenced database (GIS) – and for processing and validation such data, including remote sensing data, flood inundation support. If the LiDAR data acquisition is initiated then the team must start processing the same.

River Basin & Flood Modelling team may venture into water quality modelling based upon the availability of time & capacity after setting aside the same for improving the already developed models

Sedimentation and River Engineering may take up responsibility for studying more localised problems such as erosion and deposition, scour around structures, embankment stability etc. This unit will from the outset, have to provide modelling services to evaluate design proposals and to provide design parameters for river works in close collaboration with PMC.

Public Awareness and Media Relations: will carry out Sociological Surveys, Stakeholder Consultations, Public Relations and Information Dissemination including Publications-

1.7 TRAINING

Training is an important activity carried out in any Centre of Excellence. The training activities could be classified according to status of the trainees

Internal Training: The skills of the staff of the Centre have to be continuously improved through on-the-job training and more formal courses which are to be proposed and organised by the MC.

External Training of other staff within WRD and other related Divisions

Training Courses advertised outside the Division

Training of Client's professional in using tailor-made modelling tools developed for specific projects.

The last named category of training is either paid for through the project, or happens automatically because the visiting staff are assigned to work within the centre in developing the modelling tools.

1.7.1 Internal Training for Staff at MMC

This is the most important activity because it holds the key to continuity and sustainability. While it necessary to impart basic and advanced training to a larger number of candidates at the beginning of the project, this is essential for bringing the team up to speed. The internal training programmes are the following for specially selected groups of candidates:

Basic Training programmes in 1D modelling for the beginners and trainees

A field measurement training programmes for discharge measurements and cross sectional surveys and bed material sampling

Short practical course in data processing

On-the-job Training in setting up & running models

Advanced training in modelling for small groups – in- house or out of state

Sediment and morphological modelling – small groups

Training courses will be conducted in-house by the Managing Consultant's team, senior modellers of MMC and by some subjects specialists brought in for the purpose.

There is scope for providing opportunities for postgraduate education in India and abroad to promising staff. It has been the experience of other Centres of Excellence that the specialised work experience provided by the Centre makes it very much easier for some candidates to obtain scholarships (eg to IHE, Delft and AIT, Bangkok) without any input for the employer (except granting leave of absence).

1.7.2 External Training Offered to Government Officials

These courses will be organised and scheduled to complement the internal training programme to fit with the training needs of WRD. This programme would also serve to inform the user group of the potential of model application to assist the work of the Division – and to attract future new staff to MMC.

It is proposed for the following recommended trainings, that the officials be selected by the Principal Secretary keeping in mind maximum benefit to the MMC; preferably including ranks of HODs and above.

Advertised Training Courses:

It is envisaged that later in the project period (tentatively after Phase I) it would be possible to offer paying training course to engineers outside the government sector.

The MMC will have, working directly with the Head of MMC, the *Training Coordinator* who, in consultation with the Heads of Sections will hold the Managing Consultants to their

responsibility for organising and scheduling Training courses according to their proposal and for compiling and maintaining a growing library of training materials. The Coordinator is to be responsible obtaining approval for the training schedule from the Principal Secretary through the Director.

Overseas Study Tours (recommended)

There is a case for the exposing decision makers from the COE, preferably to the management of other difficult rivers in the world. Two such rivers are the Yellow river in China and the Rhine River in Europe.

The Hwang Ho (Yellow river) is also known as China Sorrow. The Yellow River Basin is also the cradle of Chinese Civilisation. It is also the world’s most sediment laden river – a large scale and parallel (but not identical) example of the Kosi. The people of China have over many centuries studied and devised methods of managing the river. It would be instructive for a senior delegation from Bihar to visit the Yellow river Authority and study how they manage the river.

A senior delegation from Assam had also recently visited the Yellow River. Table 2 below is based on their successful visit. The actual dates and details must be worked out in consultation with the hosts.

Table 2-Proposed Outline of Yellow River Study Tour

DAY	LOCATION	ACTIVITIES
Day 0	India	Start from India: Patna-Kolkata
Day 1	Zhengzhou	Arrival Zhengzhou: via Hong Kong
Day 2	Zhengzhou	am Introduction to the Yellow River and Flood Management Visit the yellow River Flood Management Centre pm Visit the Yellow River Museum
Day 3	Zhengzhou	am Workshop on: - River Basin Master planning - Flood control - Water and Sediment regulation Pm Field visit to Huayuankou: -Yellow River Embankments, Dikes, Groyne System

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Day 4	Zhengzhou	am	Workshop on: - Sediment control - Dyke safety monitoring
		pm	Field visit to Hydraulic Laboratory of Lower Yellow River (Physical model)
Day 5	Luoyang		Drive to Luoyang city(200 km away) Visit the Xiaolangdi Multi-purpose dam on YR Visit the Xixia yuan dam on YR
Day 6	Zhengzhou	am	back to Zhengzhou
		pm	Visit Zhengzhou CBD urban Flood Management System and Artificial wetland
Day 7			Fight back to India

The Rhine River, the most important European River bears very little resemblance to any sediment laden Asian river. However, it is a river that has been studied in detail over many centuries and managed in meticulous detail by the many countries it traverses. It is also the river where many techniques of river engineering has been studied and executed – being the subject studied at the major European Hydraulics Laboratories.

A study tour of the Rhine will thus be of interest to those whose work is concerned with the management of a major river such as the Ganga even more than that of the Kosi.

Table 4 Proposed Outline of Rhine River Study Tour

DAY	PROGRAMME
1	Departure Patna by Air
2	Arrive in Zurich
3	Visit Rhine River falls
3-4	Travel by train to Germany via France, visiting Rhine River system on the
5	Rhine River meetings, site visits
6	Arrive Koblenz, Germany, Rhine river study by Ship, overnight at Frankfurt
7	Site visits, evening flight to Copenhagen
8-9	Site Visits to DHI or Deltares
10	Depart for India

1.7.3 Responsibility of Trainings

The internal training could mostly be done within the normal MMC budget except for bringing in outside trainer and paying for course held outside Patna. It is expected that all

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other training would be paid for by the beneficiary agencies and organised by the Managing Consultant.