

# Training Design Paper on Mathematical Modelling of Ground Water System by using Visual MODFLOW Software to the Newly Joined Hydrogeologists of Central Ground Water Board

**Research Article**

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**Abstract**

As part of training programme on Management of Training (MoT) the Training Design Proposal on Mathematical Modelling of Ground Water System by using Visual MODFLOW software to the newly joined Hydrogeologists of Central Ground Water (CGWB), Govt. of India has been prepared. A MoT paper can strengthen the professional competence of the officials working with various Regional and State Unit offices of CGWB and it can ensure the stakeholders participation to achieve the set objectives of the CGWB. The CGWB is the National Apex Agency entrusted with the responsibilities of providing scientific inputs for management, exploration, monitoring, assessment, augmentation and regulation of ground water resources of the country consisting of Hydrogeologists, Geophysicists, Chemists, Hydrologists, Hydrometeorologists and Engineers and has its headquarters at Faridabad. Major activities being taken up by CGWB include various R&D studies, exploratory drilling programme, monitoring of ground water and its management. The Rajiv Gandhi National Ground Water Training & Research Institute (RGNGWT&RI) is the training and research institute of CGWB and is envisaged to function as a 'Centre of Excellence' in training ground water resources personnel and objective of these trainings is to develop a pool of trained resource persons who would be working towards sustainability of ground water resource. The aims and objectives, performance problems, various environmental, motivational and behavioural problems have also been incorporated in the MoT paper. Training and non-training recommendations, Training Plan, Priority List and design brief are the other highlights of the paper. The MoT paper recommends training and non-training implications, training design, New MoT Systems with various types of activity during the ILTC training. These include (a) Flip chart preparation, (b) Recap (c) Presentation and (d) Exercises involving all the trainees were introduced to fully engage and involve the trainees. The motivational factors to the trainee officials like various types of incentive, good entry certificate, appreciation letter from Line Managers for their outstanding performance, proper transparent promotion and transfer policies. The post training external validation should be carried out by obtaining report on the performance of the trainees from Line Managers (1-8).

**Keywords:** Management; Design; Evaluation; Assessment; Validation; Line managers

**Abbreviations:** MoT: Management of Training; CGWB: Central Ground Water; TNA: Training Needs Analysis; SWOT: Strengths, Weaknesses, Opportunities, and Threats; EMB: Environmental Management Bureau; ToS: Training Objectives; EOs: Enabling Objectives; GPS: Global Positioning System; PET: Pre Evaluation Test

**Introduction**

The determination of manpower requirements in terms of quantity and quality is one of the most problems in manpower planning. While the quantitative aspect deals with determining the total amount of work to be done in a particular period of time and the number of workers required to do it, the qualitative aspect deals with the type of people needs to be employed for doing the

work. The CGWB is a Sub-ordinate organisation under the Ministry of Water Resources, River Development & Ganga Rejuvenation, Govt. of India with well-defined job, and / or task levels. The CGWB is a multi-disciplinary scientific organization consisting of Hydrogeologists, Geophysicists, Chemists, Hydrologists, Hydrometeorologists and Engineers and has its headquarters at Faridabad, Haryana. Major activities being taken up by CGWB include macro/micro-level ground water management studies, exploratory drilling programme, monitoring of ground water levels and water quality through a network of ground water observation wells comprising both large diameter open wells and purpose-built bore / tube wells, implementation of demonstrative schemes for artificial recharge and rainwater harvesting. The CGWB also takes up special studies on various aspects of ground water sector such as ground water depletion, salinity ingress,

ground water contamination, conjunctive use of surface and ground water, water balance etc. It also organizes various capacity building activities for personnel of its own as well as Central / State Government organizations engaged in different fields of ground water sector as well as mass awareness campaigns on the importance of water conservation and judicious ground water management. The CGWB publishes scientific reports based on the data generated through various investigations for benefit of the stakeholders (9-17).

The Rajiv Gandhi National Ground Water Training & Research Institute (RGNGWT&RI) is the training and research institute of CGWB and is envisaged to function as a 'Centre of Excellence' in training ground water resources personnel. Realizing the need to provide trainings to ground water professionals, sub-professional and other stakeholders the Institute has embarked upon a three tier training program. The objective of these trainings is to develop a pool of trained resource persons who would be working towards sustainability of ground water resource. In Tier- I Training, the trainings are provided in core ground water areas with scientific input to state and central level ground water professionals and sub-professionals in the Institute at Raipur.

### Study area and performance problem

The performance problem exists in the client organisation due to the lack of knowledge and skill on Mathematical Modelling of Ground Water System by using Visual MODFLOW Software to the newly joined Hydrogeologists of CGWB is described below. The newly joined Hydrogeologists of CGWB will not be able to carry out Mathematical Modelling of Ground Water System by using Visual MODFLOW software. Thus the client organization is not able to interpret hydrogeological characteristics of ground water, forecast the probable adverse effects and publish technical reports with R&D components in time. This has resulted in the credibility loss to the organization and the stakeholders are not utilizing the data due to its ineptness. Many performance problems in the Client organisation are related to environmental, motivational and behavioural categories which are affecting successful performance of Client officers. Some of the identified performance problems, their Symptoms and Causes include:

- a. **Performance problem:** Newly joined Hydrogeologists lack knowledge and skills for interpreting hydrogeological data and submit report in time.
- b. **Symptoms of the problem:** The trainee Hydrogeologists lack knowledge and skill in operating software, analyse and interpret hydrogeological data using Visual MODFLOW software and the Client cannot publish technical reports with R&D components in time and the CGWB lost its credibility among R&D organisations.
- c. **Causes of problem:** The various causes include to environmental, motivational and behavioural categories existing in the Client organisation, Procurement of software like Visual MODFLOW, motivation to performers by incentive / appreciation letter / good entry certificate / foreign exposure, proper promotion policy and proper transfer policy.

Impart knowledge and skill to newly joined Hydrogeologists of CGWB on Mathematical Modelling of Ground Water System by using Visual MODFLOW software and train them to interpret

hydrogeological characteristics and publish technical reports with R&D components in time is the training need. Many occasions the Line Managers seek the help of other agencies (outsourcer) for carrying out the Mathematical Modelling of Ground Water System by using Visual MODFLOW software. Now the Training Manager and Line managers are not ready to outsource the work and insisting to impart training on Mathematical Modelling of Ground water system and wanted to reduce the performance gap among the newly joined Hydrogeologists.

### Materials and Methods

The methodology adopted in the data collection and evidence include

- a. Primary and secondary data collection,
- b. Interview and observation, and
- c. The various Training Needs Analysis (TNA) tool kits.

The various TNA tool kits used during the various phases are Terms of reference ([Annexure I](#)) and surveillance (Phase I-Entry and contracting), SWOT and EMB factors (Phase II-Data collection).

### Entry and contracting

Terms of reference-The Terms of reference with the Client is compiled ([Annexure II](#)).

- a. Surveillance-Surveillance of available primary and secondary data about the client organisation is collected from Website of CGWB and personal interviews with the stakeholders.
- b. SWOT Analysis.

The 'SWOT' is a mnemonic for an analysis of four factors related to an organisation's performance viz. strengths, weaknesses, opportunities and threats. The strengths of organisation are attributes of organisation helpful in achieving the objectives. Weaknesses are attributes harmful in achieving organisational objectives and areas of improvements. Opportunities are external conditions which are helpful in achieving objectives. Threats are the factors which could do damage to the objectives of the organisation. The data collected during SWOT analysis is compiled ([Annexure III](#)).

### Environmental, motivational and behavioural factors

This tool is used to distinguish performance factors directly linked to training needs and other non-training factors that also require attention.

### Data analysis (Segregation of symptoms /Causes) and observations

The methodology adopted in the data analysis and observations include

- a. Primary and secondary data collection,
- b. Interview and observation, and
- c. The various TNA tool kits.

The various TNA tool kits used during the various phases are Cause & Effect (Fish bone) analysis (Phase III-Analysis & Diagnosis), Performance report and Priority list (Phase IV-feedback) and Training plan, Design brief and TNA report (Phase V-Withdrawal).

**a. A cause & effect (fishbone) analysis**

The Cause and effect analysis enables to analyse a particular performance problem in more detail. Often, a problem is apparent through one, or perhaps several ‘symptoms’ that indicate faulty performance. It is also known as “Fishbones” (because of their shape) or Ishikawa diagrams (after their inventor, Dr Ishikawa,

the Japanese Quality Control Statistician). It is a systematic way of looking at effects and the causes that create or contribute to specific performance problems. The problem being analysed can be expressed as a deficiency or as “desired state”. The analysis focuses attention on either a detailed analysis of the causes of the problem, or seeking ideas for its solution.

This tool identifies the problem area or “effect” to be analysed or the desired state to be reached by holding brainstorming sessions with the stakeholders to establish all the major possible causes and effect. The Cause and Effect diagram has been prepared (Figure 1).

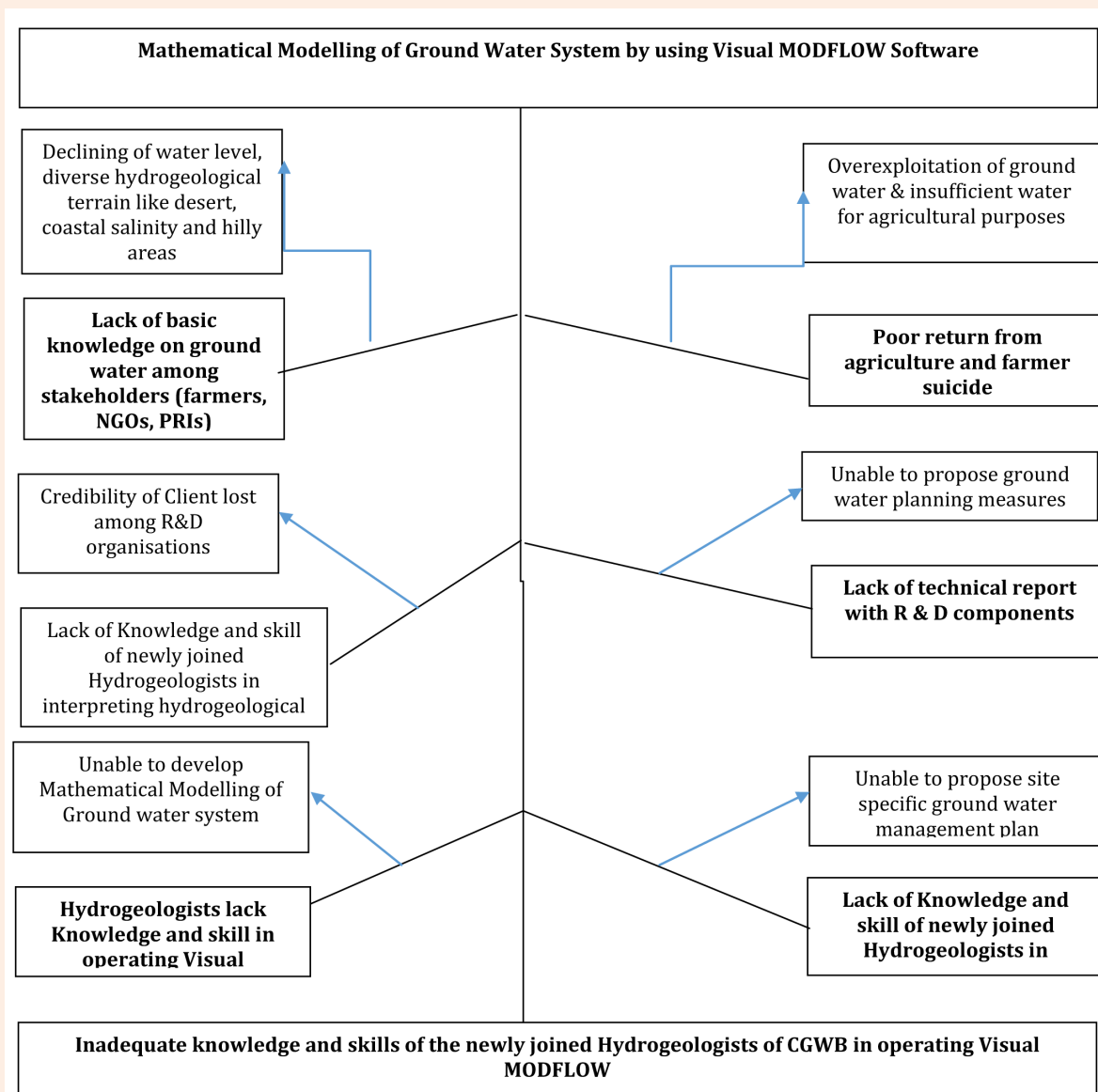


Figure 1: Cause & Effect (Fish bone) Analysis.

## Results and Discussion

The various Training Needs, factors, Training and Non-Training Implications, Design brief, learning event, Performance Assessment, Validation and Evaluation of Training and budget are discussed in brief (17-20).

### Identification of training needs

The training needs are described under training and non-training implications, knowledge, skill, attitudinal deficiencies and training strategy proposed.

### Training and non-training implications

There are many performance problems related to environmental, motivational and behavioural categories affecting successful performance of client organisation were identified

during the interaction with the Client and stakeholders. The factors contribute the environment in which they are performing, includes all the tools, equipment, materials and logistical support necessary for successful performance. The persons are motivated to perform at high standard, if they find it rewarding to do something to the best of their ability. The person has the necessary behaviour (or knowledge and skill) to carry out the tasks at high standard, they are required to perform. The EMB factors in the client organisation are compiled (Table 1).

The environmental and motivational factors affecting the desired performance in CGWB related to non-training implications but those of behaviour (or knowledge and skill) need training interventions. The training intervention and non-training implications urgently required in the client organisation are compiled (Table 2).

**Table 1:** EMB Factors in the client organisation.

Environmental Factors (Non-Training Factors)	Motivational Factors (Non-Training Factors)	Behavioural Factors (Training Factors)
Lack of sufficient fund for improvements. Lack of knowledge and skill of stakeholders in operating different software. Lack of adequate hydrogeological data analysis expertise. Lack of three dimensional aquifer map. Lack of organised work pattern in different regions. Lack of proper transfer policy.	No incentives and promotions on additional qualification and performance of officers /officials. No proper promotion policy.	A capacity building training should be given to newly joined hydrogeologists on Visual MODFLOW software.

**Table 2:** Training Intervention and non-training implications.

Training Interventions	Non-Training Implications
Newly joined Hydrogeologists of CGWB lack knowledge and skill in operating Visual MODFLOW software.	Procurement of Visual MODFLOW software.
Newly joined Hydrogeologists lack necessary skill in analysis of hydrogeological data.	Motivation to performers by incentive/appreciation letter/ foreign.
Newly joined Hydrogeologists of CGWB lack necessary skill in interpretation of hydrogeological data.	Exposure.
Newly joined Hydrogeologists of CGWB lack knowledge and skill in developing Mathematical Modelling of Ground Water System using Visual MODFLOW software.	Proper promotion policy.
Newly joined Hydrogeologists of CGWB lack knowledge and skill in submitting technical reports with R&D components in time.	Proper transfer policy.
	Implementation of proper timely ground water management policy.



### Knowledge, skill, attitudinal deficiencies

Like other organisations, factors affect performance of the client organisation can be categorized into EMB factors. The environmental factors are all the tools, equipment, materials and logistical support necessary for successful performance. The motivational factors intended to perform to a high standard; they find it rewarding to do something to the best of their ability and the behavioural factors- (or knowledge and skill) to carry out to a high standard and the tasks they are required to perform and are related to training. The behavioural factors are the ones essential to analyse during a TNA consultancy and is the heart of TNA. It is the main contribution one can make towards helping an organisation to improve its performance. By these knowledge and skill of workers may be increased. Behavioural factors are to be analysed during a TNA consultancy. Concentrate time and

energies towards identifying areas of knowledge and skill where there is an attractive cost / benefit potential.

The newly joined Hydrogeologists of Central Ground Water CGWB will not be able to carry out Mathematical Modelling of Ground Water System by using Visual MODFLOW software. Thus the client organization is not able to interpret hydrogeological characteristics of ground water, forecast the probable adverse effects and publish technical reports with R&D components in time. This has resulted in the credibility loss to the organization and the stakeholders are not utilizing the data due to its ineptness. Many performance problems are related to environmental, motivational and behavioural categories which are affecting successful performance of Client officers. Some of the identified performance problems are incorporated (Table 3).

**Table 3:** Performance Problems in Client organisation.

<p><b>Performance Problem:</b> Newly joined officers / officials lack knowledge and skills for interpreting hydrogeological data and submit report in time.</p>
<p><b>Symptoms of the problem:</b> The trainee officials lack Knowledge and skill in operating software, lack of knowledge and skill to analyse and interpret hydrogeological data using Visual MODFLOW software and the client cannot publish technical reports with R&amp;D components in time and the CGWB lost its credibility.</p>
<p><b>Causes of Problem:</b> The various causes include to environmental, motivational and behavioural categories existing in the Client organisation, Procurement of software like Visual MODFLOW, motivation to performers by incentive/appreciation letter / good entry certificate / foreign exposure, proper promotion policy and proper transfer policy.</p>

### Training strategy proposed

The training strategy proposed includes one learning event with content, suitability of methods, effectiveness, provision of knowledge, skill development, media, trainers, time table and transfer and the elements of training strategy are described below.

**Content:** The various contents associated with the Learning Event are Basic Hydrogeology, GPS, Mathematical Modelling, Ground Water System, MODFLOW software Design and Conceptualization, A list of Do's and Don'ts, Topo sheet, geological map, tracing sheet (stationeries), Handouts (to trainees), Flip Charts, Transparencies (to the trainers).

**Suitability of methods:** The various suitability of methods proposed for the training includes lecture, demonstration and coaching. The theory portions can be covered by Lecture and it is purely trainer centred. The demonstration and coaching are the best methods for imparting knowledge and skill to the trainees. As the work involves mainly skill development and handling software, equipment and tools, Demonstration and Coaching are the most effective methods of imparting knowledge and skill.

**Effectiveness:** The effectiveness of the training depends on the knowledge, skill and change in attitude of the trainees during the training period. The effectiveness of the training is related to performance and it can be done by performance assessment. The performance of trainees during the course of training can be assessed by formative and summative assessments. The trainer can do various types of internal validation by carrying out Pre evaluation test, MCQs, slip test, Quiz, exercises, projects, post evaluation test and so on. The effectiveness in terms of performance at the client organisation can be carried out by the

Line Managers in the different regional offices of CGWB (external validation). The effectiveness of training in terms of performance assessment can be evaluated by the client for the client's satisfaction and justification for the investment in training.

**Provision of knowledge:** As the newly joined hydrogeologists of CGWB lack knowledge and skill, their confidence and competence to take up hydrogeological work independently in the organization is a challenging one. They will not be able perform effectively without imparting knowledge and skill components for the better planning and management of ground water resources. The design brief creates better opportunities for the same. In addition to lecture, coaching in the field and lab make them to enhance their knowledge and skills. The demonstration, hands on sessions and various performance aids such as Manuals on GPS and Visual MODFLOW Software, well inventory forms and Manual on Field survey etc give provision of knowledge.

**Skill development:** The newly joined hydrogeologists of CGWB lack knowledge and skill in operating Visual MODFLOW software. As they lack skill in operating the software, they will not be able to develop Mathematical Model of Ground Water System pertaining to different hydrogeological set up. Training design is mainly for imparting knowledge and skill in operating Visual MODFLOW software and equip them to include Mathematical Modelling of Ground Water System pertaining to different hydrogeological set up. The skill development include observation and collection of hydrogeological details by well inventory Viz., depth to the water table, diameter, depth of curving, aquifer material, depth of well, quality of water, recharge area to the wells. Determination of geo references like latitude and longitude by using GPS, to represent in topo sheets etc. are the related skill developments proposed.

**Media:** For imparting best possible inputs to the trainees for nullifying the performance gap the various media have been proposed. These include Power-Point Presentation, White CGWB writing, Topo sheet, Geological map, Tracing sheet, Stationery, Note book, Exercises Maps, GPS, Well inventory forms, Writing pad, Measuring tape, and Computers loaded with software (Micro soft office and Visual MODFLOW).

**Trainers:** The proposed entry level hydrogeologists are belonging to Group A Gazetted, and for their training purpose senior level officers in the rank of one Superintending Hydrogeologist assisted by two Sr. Hydrogeologists are proposed. The Superintending Hydrogeologist assisted by two Sr. Hydrogeologists should be well experienced and have thorough field hydrogeological knowledge on different geological terrains.

**Time table:** Training design proposal on Mathematical Modelling of Ground Water System by using Visual MODFLOW to the newly joined Hydrogeologists of Central Ground Water CGWB has been proposed for 5 days. The each day has 4 sessions, tea and lunch breaks and interaction sessions. The detailed break up is compiled ([Annexure II](#)).

**Transfer:** Transfer of learning event is link between classroom performance and expected improved performance by the trainees at their workplace. Transfer of training is effectively and continuing applying the knowledge, skills, and/or attitudes that were learned in a learning processes to the job environment. Closely related to this concept is Transfer of Learning- the application of skills, knowledge, and/or attitudes that were learned in one situation to another learning situation. This increases the speed of learning. The first place to practice transfer of learning is within the training classroom and then in work environment. This makes it much easier to transfer new skills and knowledge to the job. Transfer of learning is the influence of prior learning on performance in a new situation.

The training details like objectives, content defined in relation to objectives, time and timing considered, appropriateness of training methods, media specified and appropriate trainer(s) taken into account, performance aids and transfer of learning taken into account are compiled ([Annexure II](#)).

## Design Brief

In the design Proposal on Mathematical Modelling of Ground Water System by using Visual MODFLOW Software to the newly joined Hydrogeologists of Central Ground Water CGWB various parameters such as aim of training, Constraints, Benefits, Outcomes, Target group/s and Target population are considered. These parameters are briefly discussed.

### Aim of training

The CGWB will be able to publish technical reports with R&D and forecast components in time. It can again come to the central stage among R&D institutions with good track record. The stakeholders will be able to access the hydrogeological data in time and initiate measures to protect the resource. The client organization can propose site specific sustainable development of ground water resources and able to develop Mathematical Modelling of Ground Water System by using Visual MODFLOW Software.

### Constraints

The large number of newly joined hydrogeologists to be given training. But the Line Managers are not in a position to send or depute all of them at a stretch but it can only depute a few Officers as batches. The Training Institute (TI) also cannot take more than 25 Officers at a time for a particular course and the TI cannot impart a training in this field for all the officers at a stretch because large number of courses will be organised throughout the year by the TI.

**Location:** Training Institute of Central Ground Water CGWB (Rajiv Gandhi National Ground Water Training & Research Institute) is situated at Raipur and the accessibility of TI from different Regional offices is very much limited. Training will be carried out in 6 Regional offices of Central Ground Water CGWB (20 participants at each office) at Hyderabad in South, Lucknow in North, Ahmedabad in West, Kolkata in East, Nagpur in Central and Guwahati in North East.

**Time:** During monsoon (July to September) to ensure maximum participation of the trainees. Non-monsoon period the trainee hydrogeologists will be in the field.

**Duration of training** - 5 days. In many occasions Line Managers may not be able spare the availability of newly joined hydrogeologists even for 5 days due to work pressure.

### Benefits

The various benefits (at the end of the training) include:

- Hydrogeologists will be able to interpret hydrogeological data of various ground water abstraction structures such as dug well, tube well, bore well, dug-cum- bore well, filter point wells and tunnel wells.
- The CGWB will be able to disseminate data timely through publication of technical reports and stakeholders will be able to utilize the reports for effective ground water management, and
- The organizational efficiency and credibility will improve (21-28).

### Outcomes

Impart knowledge and skill to newly joined Hydrogeologists of Central Ground Water CGWB on Mathematical Modelling of Ground Water System by using Visual MODFLOW software and train them to interpret hydrogeological characteristics and publish technical reports with R&D components in time. Many occasions the Line managers seek the help of other agencies (outsources) for carrying out the Mathematical Modelling of Ground Water System by using Visual MODFLOW software. Now the Training Manager and Line managers wanted to impart training on Mathematical Modelling of Ground water system and wanted to reduce the performance gap among the newly joined Hydrogeologists.

The outcomes of the training also depends on the training objectives (TOs). The TOs include:

**TO.1:** Trainees will be able to prepare base map of area and generate ground water related data in field and submitting data

to the Client organization.

**TO.2:** Trainees will be able to interpret the data by carrying out Mathematical Modelling of Ground Water System by using Visual MODFLOW software.

**TO.3:** At the end of the training session, the trainees will be able to reply to queries (open house), carry out individual exercises and independently interpret water quality data by using Visual MODFLOW software.

### Enabling objectives (EOs) of TO.1

**Trainees will be able to**

- a. **EO-1:** Prepare base map of the study area for representing hydrogeological inputs,
- b. **EO-2:** Establish optimum numbers of wells for ground water related data collection,
- c. **EO-3:** Use Global Positioning System (GPS), and
- d. **EO-4:** To identify the source and collect hydrogeological well inventory details.

### Enabling objectives (EOs) of TO.2

**Trainees will be able to**

- a. **EO-1:** Carry out analysis of hydrogeological data including Simulation, Calibration and run the Visual MODFLOW software for the mathematical modelling of ground water system.
- b. **EO-2:** Identify ground water problems of the area by the use of mathematical modelling of ground water system , and
- c. **EO-3:** Propose management options and future strategies for effective ground water management and utilization.

### Target group

Training to be imparted to newly joined Hydrogeologists of CGWB (120 Nos) on Mathematical Modelling of Ground Water System by using Visual MODFLOW software and publish reports with R &D components in time. Training will be imparted in 6 Regional offices (20 no. in each group). The details such as those Related to needs, Number of Trainees, Assumptions about Trainees and Assessing Entry Behaviour of target group have been considered.

**Related to needs:** In order to develop Mathematical modelling of Ground Water System by using Visual MODFLOW to the newly joined Hydrogeologists of Central Ground Water CGWB, the trainers should have basic education of MSc, M Tech in Geology/ Applied Geology with basic knowledge on Basic Hydrogeology, Ground Water Flow equations, Darcy’s law and Finite difference solution to 3D ground water flow equation.

**Number of trainees:** The 120 trainees (6 groups -20 no. in each group) should be trained at six regional offices of CGWB.

**Assumptions about trainees:** The basic knowledge of hydrogeological characteristics of water and minimum knowledge on Microsoft Office especially Microsoft Excel.

**Assessing entry behaviour:** The profile of Trainees received from the client.

### Target population

The target population details are compiled under Entry behaviour of newly joined Hydrogeologists of CGWB (Table 4).

**Table 4:** Entry behaviour of newly joined Hydrogeologists of CGWB.

#	Item	Entry Behaviour
1	Education	MSc, MTech in Geology/Applied Geology
2	Age group	25 – 35 years
3	Experience	1-3 years
4	Location	Working in different Regional offices of CGWB
5	No. of trainees	120 trainees (6 groups -20 no. in each group)
6	Available period for training	Monsoon (July–Aug.- Sept)
7	Nature of group	Homogeneous

**Table 5:** Details of internal validation of the training.

Particular	Fully	Partially	Not at All
Relevancy of the contents			
Implementation at work place			
Are objectives achieved			

### Learning Event

The content, suitability of methods, effectiveness, provision of knowledge, skill development, media used, trainers, time table and transfer related to learning event are described below and the detailed break up is compiled (Annexure II).

### Content

The various contents associated the present training design on with the Learning Event are Basic Hydrogeology, GPS, Mathematical Modelling, Ground Water System, MODFLOW software design and conceptualization, a list of do’s and don’ts, topo sheet, geological map, tracing sheet (stationeries), Handouts (to trainees) and Flip Charts, Transparencies (to the trainers).

## Suitability of methods

The various suitability of methods proposed for the training includes lecture, demonstration and coaching. The theory portions can be covered by Lecture and it is purely trainer centred. The demonstration and coaching are the best methods for imparting knowledge and skill to the trainees. As the work involves mainly skill development and handling software, equipment and tools, Demonstration and Coaching are the most effective methods of imparting knowledge and skill.

## Effectiveness

The effectiveness of the training depends on the knowledge, skill and change in attitude of the trainees during the training period. The effectiveness of the training is related to performance and it can be done by performance assessment. The performance of trainees during the course of training can be assessed by formative and summative assessments. The trainer can do various types of internal validation by carrying out Pre evaluation test, MCQs, slip test, Quiz, exercises, projects, post evaluation test and so on. The effectiveness in terms of performance at the client organisation can be carried out by the Line Managers in the different regional offices of CGWB (external validation). The effectiveness of training in terms of performance assessment can be evaluated by the client for the client's satisfaction and justification for the investment in training.

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## Media

For imparting best possible in-puts to the trainees for nullifying the performance gap the various media such as Power-Point Presentation, White board writing, Topo sheet, Geological map, Tracing sheet, Stationery, Note book, Exercises, Maps, GPS, Well inventory forms, Writing pad, Measuring tape, and Computers loaded with software (Micro soft office and Visual MODFLOW) have been proposed.

## Trainers

The proposed entry level hydrogeologists are belonging to Group A Gazetted, and for their training purpose senior level officers in the rank of one Superintending Hydrogeologist assisted by two Sr. Hydrogeologists are proposed. The Superintending Hydrogeologist assisted by two Sr. Hydrogeologists should be well experienced and have thorough field hydrogeological knowledge on different geological terrains.

## Time table

Training design proposal on Mathematical Modelling of Ground Water System by using Visual MODFLOW to the newly joined Hydrogeologists of Central Ground Water Board has been proposed for 5 days. The each day has 4 sessions, tea and lunch breaks and interaction sessions. The detailed break up is compiled ([Annexure II](#)).

## Transfer

Transfer of learning event is link between classroom performance and expected improved performance by the trainees at their work place. Transfer of training is effectively and continuing applying the knowledge, skills, and/or attitudes that were learned in a learning processes to the job environment. Closely related to this concept is Transfer of Learning—the application of skills, knowledge, and/or attitudes that were learned in one situation to another learning situation. This increases the speed of learning. The first place to practice transfer of learning is within the training classroom and then in work environment. This makes it much easier to transfer new skills and knowledge to the job. Transfer of learning is the influence of prior learning on performance in a new situation.

## Performance Assessment, Validation and Evaluation of Training

The performance assessment of trainees can be assessed by both formative and summative means.

## Formative assessment

Occurs in the short term, as trainers are in the process of making meaning of new content and of integrating it into what they already know. Feedback to the learner is immediate (or nearly so), to enable the learner to change his/her behaviour and understandings right away. Formative Assessment enables the trainer to and rethinks instructional strategies, activities, and content based on trainees understanding and performance.



The formative Assessment can be as informal as observing the learner's work or as formal as a written test. Formative Assessment is the most powerful type of assessment for improving trainers understanding and performance. The formative Assessment proposed include group discussion, MCQ, a warm-up, slip test, on-the-spot performance, pre evaluation test (PET-I) and Quiz.

### Summative assessment

Takes place at the end of the training, with the results being primarily for the trainer's or Course Director's use. The Criterion reference type of assessment is proposed for the performance assessment. Thus those gets 70% or above will be eligible for certification eg:- Major cumulative projects, research projects, and performances, post evaluation test (PET-II).

### Validation

The performance assessment of trainees can be assessed by various types of validation. The two methods of validation are internal and external Validations.

#### Internal validation

The internal validation is carried out by the trainer by conducting number of tests during the training period. The internal validation as per the following feedback (Table 5). The internal validation provides trainers with feedback about the training they provide, checks whether the trainees have achieved the specified objectives, enables the quality of training to be monitored, indicates where the effectiveness of training can be

improved and can be effectively delivered and provides the basis for certification.

#### External validation

The external validation can be done after the training programme at the work place of trainees. The external validation will be done by Line Managers after 2 to 3 months. The external validation focuses on actual performance. It can be related to identified training needs, establishes the basis for the transfer of leaning, indicates the validity of the specified training objectives, can be used as evidence of competence, provides essential data for cost benefit analysis and proves the benefits being obtained from training.

#### Evaluation

Evaluation will be done by senior management, accountants, consultants, or by customers. The reasons for doing evaluation of training include it recognises the importance of satisfying the needs of the clients. It provides justification for the investment of training, establishes the benefits of having a training function, encourages management to make further investment in training, enables training to be evaluated from different perspectives. The evaluation includes cost benefit analysis, provides professional discipline for training management and encourages careful scrutiny of training proposals.

#### Budget

The budget details of the training are compiled (Table 6).

**Table 6:** The budget details of the training.

Particular for One Training	No of Participants /Session	No of Days	Unit Cost (Rs)	Total (Rs)
Training Kit	20 Participants	-----	500	10000
Refreshment including Lunch	20 Participants	5	200	20000
Honorarium	-	-	-	
Stationery		Lump sum	4000	4000
Training Aid		Lump sum	2000	2000
Miscellaneous		Lump sum	2000	2000
Total amount for one Training				38000
Total for six Trainings Rs. 38000 x 6 = Rs. 228000				

The budget details of the training are compiled.

### Conclusion

Training Design Paper on Mathematical Modelling of Ground Water System by using Visual MODFLOW Software to the newly joined Hydrogeologists of Central Ground Water Board has examined various measures to be adopted for the performance enhancement of the client organization. The design brief summarises the main highlights of initiatives to be adopted by the

Training Manager and Line Mangers of the client organisation.

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