LECTURE PAPERS
FOR
TRAINING OF ASSISTANT ENGINEERS / MARCH, 1975

PUBLIC HEALTH ENGINEERING

Govt. of the Peoples Republic of Bangladesh

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DIRECTORATE OF PUBLIC HEALTH ENGINEERING

TRAINING PROGRAMME FOR ASSISTANT ENGINEERS

Training Centre :- Kaptai Engineering Academy

TIME SCHEDULE & COURSE OUTLINE

Date and Time	Content	Speaker
Monday, March 24, 1975		
0900 - 1130	Inaugural Session	
1130 - 1230	Organization of DPHE. A Perspective View (to Young Engineers)	Mr. M. A. Hussain, Chief Engineer, DPHE.
1400 - 1445	Role of WHO	Mr. V. P. N. Nayar, WHO Sanitary Engineer.
1445 - 1530	Role of UNICEF	Mr. J. F. Shawcross, Water Programme Manager, UNICEF
1545 - 1700	Basic Information Ground Water	Mr. K. A. W. Asgar, Executive Engineer, DPHE, Ground Water Explo. & Dev. Division.
Tuesday, March 25		
0900 - 1030	Rural & Urban Sanitation	Mr. V. P. N. Nayar, WHO Sanitary Engineer.
1045 - 1215	Well Hydraulics & Well Design	Mr. M. Akhter, Ground Water Engineer, UNICEF
1400 - 1645	Laboratory Practices for Water Quality Control (including Lab. demonstration).	Mr. Aminuddin Ahmed. Executive Engineer, DPHE Design Div.
Wednesday, March 26	Field Work (Demonstration Tubewell & Platform)	Mr. Abdul Awal, Water Supply Consultant, UNICEF. Mr. Firoze Ahmed, Executive Engineer, DPHE Chittagong Div.

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Date and Time	Content	Speaker
Thursday, March 27		
0900 - 1030	Work rules, Office Rules, Finance Rules, Responsibilities of Asstt. Engineer. Supervision of construction, Observance of Specification.	Mr. M.H.Khan. Superintending Engineer, DPHE, Khulna Circle.
1045 - 1215	Stores Management Procedures, storage of Cement & other materials & maintenance of vehicles.	Mr. S. A. K. M. Shafique, Executive Engineer, DPHE Stores Division, Dacca.
1400 - 1515	Sinking & Resinking of Hand Tubewells.	Mr. M. Rahman, Executive Engineer, DPHE. P&C Div.
1530 - 1645	Urban Water Supply	Mr. M. Hossain. Dy. Chief Engineer. DPHE.
Friday, March 28		
0900 - 1030	Repairs and Maintenance of Hand Tubewells	Mr. Q. Islam, Executive Engineer, DPHE, Barisal.
1045 - 1215	Course Content for Mechanics' Training.	Mr. M. Akhter, Ground Water Engineer, UNICEF
1400 - 1645	Organisation and Funding of Mechanics' Training	" " "
Saturday, March 29		
0900 - 1000	Health Education for Use of Tubewell Water & Better Latrines.	Mr. M.A. Rahim, Lecturer, Para Medical Instt. Dacca.
1045 - 1215	Comprehensive Test	Mr. M. Akhter, Ground Water Engineer, UNICEF.
1400 - 1445	Grading of Test and Results.	" " " "
1445 - 1530	Closing Session - Award of Certificates	Mr. Perry Hanson, UNICEF Representative, Dacca, Bangladesh.

TRAINING PROGRAMME
FOR
ASSISTANT ENGINEERS
OF
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH

SUBJECT: ORGANIZATION OF DPHE
—A PERSPECTIVE VIEW

M. A. Hussain
Chief Engineer, DPHE

March, 1975.

ORGANIZATION OF DPHE
—A PERSPECTIVE VIEW
(To Young Engineers)

1. INTRODUCTION:

The Directorate of Public Health Engineering (DPHE) is an organization to deal with "Public Health".

The mission of "Public Health" is to promote and protect the health of human community. The same can be better understood from the definition of "PUBLIC HEALTH" as enumerated by Dr. Winslow, an eminent Sanitarian of the U.S. Public Health Services.

"Public Health is the science and art of preventing diseases, prolonging life and promoting physical life and mental health and efficiency through organized community efforts for the sanitation of the environment ...."

In fact, man like all other species, is dependent on his relationships with the environment for his safety, health and very survival. And, in spite of that man himself has made his environment polluted through population growth and in the way of development through urbanization and industrialization. It now needs planned scientific activities to modify favourably the environment itself and to modify the intersection of human activities with the environment. This involves physical, biological, psychological and social factors. Man's physical environments are air, water, food and housing which are infested with disease causing germs and other pollution caused by man himself. His biological environments consisting of his fellowmen, animals, plants, birds, insects, fish etc. also carry billions of disease causing germs of various types which can infect him and ultimately kill him. His psychological environments are undesirable noise from vehicles, loudspeakers, factories, commercial and trade activities etc. which act heavily upon his mental health and thus cause irreparable damages to his nervous systems and thus render him sick.

And last but not the least are the social factors. Most people in society particularly in developing countries are ignorant of environmental health and sanitation. From the statistical records of Bangladesh it is found that 40 percent of the children, before reaching the age of ten, get partially disabled both mentally and physically due to attacks of various diseases and malnutrition.

Environmental health programmes, therefore, involve in full spectrum the community's social, political, economic and cultural values. And this needs two-fold attack — one from physicians for immunization and cure from imminent attack of diseases and the other from engineering on the preventive side, that is, improvement of environmental sanitation. This calls for not only engineering practices to improve environmental conditions but also cultural and social issues to change behavioural pattern of the people.

The administration of DPHE is, therefore, very very complex and quite unlike the administration of other engineering organizations like Buildings, Roads and Highways or EWDB. Unfortunately many engineers of DPHE though trained to high levels of technical competence are lacking in the knowledge of social values.

Society also being largely ignorant of cause-effect relationship of diseases cannot fully utilise the services of DPHE. People need health education. They need to be enlightened that disease and disability prevention through environmental control can help reduce the rapidly mounting costs of medical care. Also treating an existing illness is less valuable and effective than reducing the probability of an illness ever occurring. The function of DPHE is, therefore, not limited to construction only but also to give the community, health education about environmental sanitation which cover water pollution control, excreta disposal, garbage disposal, vector control etc. etc.

Planning and management of DPHE works need to be based on a perspective that looks beyond the physical output - that is, in case of Rural Water Supply, not only how many wells have been completed, but also to their social benefit which is, whether the people really use the safe tubewell water or make it unsafe through their inherent unhygienic social and cultural habits. Direct output of DPHE works, therefore, is to be measured in terms of what the population is actually deriving by way of social benefits.

2. DPHE STRUCTURE:

DPHE is an engineering organization with a Chief Engineer as head of the administration. The tiers of administration in short are, one Deputy Chief to work as immediate assistant to the Chief and 6 functional Superintending Engineers in the Administrative and Executive line. Under them there are Executive Engineers, Assistant Engineers, ~~xx xx~~ ~~xx xx~~ Sub-Assistant Engineers and Mechanics for execution, management, control and maintenance of works. Like other administrative systems DPHE operates to produce goods and services in order to achieve their missions, to justify their reason of being.

The head of the organization is responsible for and has the authority to accomplish all the works of the organization. But he accomplishes work by delegating authority and responsibilities to sub-heads who make further sub-delegation within the framework of Government rules. Such delegations are administrative in character and do not relieve the delegator of his ultimate responsibility. This is not true delegation in strict sense. At each lower level of the structure, the delegation of responsibility is defined specifically and is more detailed downwards until the basic level of job specification is reached.

The system is simply a division of labour without any prejudice as to who is at command and who is subordinate. The system is one of a cooperative enterprise with good human relations as in a family where different works are done by the male and female of different age groups.

Division of labour leads to specialization which in turn generates expertness, increased productivity and economy in the training of workers.

The organization is a rationalized system like a social system each component of which is interdependent and interacting. As an example, three strangers placed in a room do not form a social system. If they start communicating, their interaction begins to form them into a system. Should they come to depend on each other through their interactions a strong social system might develop. So only modern America and Australia have been built. It was the interaction of lots of people of European countries that helped—not by Columbus or Captain Cook alone. Another example is that a family is a system. When a member of the family dies or becomes unemployed or shows indifferent attitude, a repercussion comes in the family system. If the system is to continue as such its remaining members will have to adjust their interactions and find a new steady state. Hence it is needless to say that in an organization too if some components do not work or interact with the rest of the system, they are not in effect a part of the system and has no true relation to it. They are like dead cells, not a part of the functional body. Rather they are a problem to the system like cancer and should be cleaned off.

3. FUNCTION OF DPHE:

The function of DPHE is to plan, implement, manage, operate and maintain various Environmental Sanitation Projects. The types of works on this account are: supply of safe drinking water, collection and disposal of human excreta, disposal of garbage, industrial waste disposal, drainage system, vector control, control of water pollution, air pollution control and industrial hygiene (control of dust and noise) etc.

4. PLANNING:

Planning is an orderly process of defining a problem through the collection of data and their analysis, resulting in the formulation of proposals for a change for the better. Planning should be realistic and economically viable to meet needs that problem demands. The ultimate objectives of all DPHE planning is to reduce morbidity, mortality and disability of the population.

The major health problem of the country is water-borne diseases. Inadequate supply of safe drinking water, absence of sanitary facilities, poor health habits and lack of sanitary discipline provide an unfailing means of transmission and a growing reservoir of infection.

Priorities have therefore been given for implementing water supply and sanitation as an integral part of National Development Plans, as the desired social infrastructure for improving the national economy cannot be achieved without a health population.

5. LONG-TERM & SHORT-TERM PLANNING:

Planning should primarily be long-term based on a countrywide need for 25 or 30 years divided into several five year or short-term plans for implementation. In the absence of a long-term plan, the nature, size and scope of the problems are unknown. Successive short-term plans can be modified in the light of the experience, data collected and evaluation of the previous plan. This also helps to look ahead of time to the desired destination and to cover up any back-log. In fact planning is a continuous process of evolution and evaluation. From the days of Adam up-to-date man has planned by evolution and evaluation for better living and survival. Hence no planning can be called a complete one or fool-proof. Planning is always subject to adaptation and modification with the increase of human knowledge and experience. Hence any partially successful planning is better than no planning in the expectation of perfect planning.

It needs constant survey, data collection based on statistics and correlating them within the limit of confidence. DPHE Engineers should learn elementary statistics for this.

6. PROJECT IMPLEMENTATION:

Whether it is a development project implementation or a case of maintenance programme, decision making, control and evaluation; these three aspects are necessary for efficient management.

Decision making is defined as the determination of current and future actions in the programme administration. For this, identification of objectives and a detailed knowledge of the end results are required. Decision making is also a mechanism for deciding a corrective action from a deviation, and communicating them to pertinent elements of the organization. This is carried out in different levels in accordance with the distribution of decision making authority. If each authority does not make decisions within his sphere of competence the decision making load of higher officials will be strained, thus making the whole organization paralized or ineffective.

Control is an activity to observe whether the system is behaving in conformity with norms and, if not, what corrective action is required. This is a kind of decision making for a particular event. But in fact, control is necessary at different levels of the organization as well as from outside over the organization. The purpose of all control is to assess effectiveness, efficiency and adequacy. Control governs a system. It may be termed as the brain of the system.

Evaluation is the orderly collection, analysis and interpretation of information required to identify the alternatives for decision making. This should be carried out continuously during programme execution and also from Pilot Projects. Evaluation leads to decision making for the current programme and future planning.

It appears from the above that the three terms are interacting and interrelated. Control involves decision making and decision making is dependent en evaluation. So from deductive logic, control is dependent on evaluation. So any control either from outside or from inside, without making proper evaluation of the whole system, is confusing and ineffective.

While implementing a project programme, events and activities should be identified clearly. They are: (1) what is to be done, (2) how it is to be done (3) when it is to be done (4) what are the constituent activities (5) how these activities and events relate to each other in space and time and (6) what are the constraints. These are the pre-requisites for management of a project implementation. One of the most useful forms for working out and expressing activity pattern is the process of line flow-chart or meshed schematic diagram.

Programme scheduling should be made covering all the constraints. The major constraints are mobilization of resources: materials, human resources and fund.

Many a programme has been paralysed due to delay in importing materials or transporting difficulties. The same thing may happen with the human resources. It takes time to recruit and it is often difficult to properly train the human resources for efficient project implementation. If such constraints of mobilization and time lag be not adjusted in the implementation schedule, the start of the programme may be delayed, and idle resources will consume fund. To avoid this, time schedule, either in straight line diagram or line diagram meshed into net-work analysis may be prepared. Net-work analysis enables the planner to decide when certain critical activities have to take place and to identify those activities for which delay can be accepted. Also net-work analysis provide information about avoidable delays for completion of the project. This also reflects the type of resources required and at what time of each activity they are required. On the basis of this one can forecast when and where various expenditure of resources will be required and can present requests for funds for particular time periods.

7. UNICEF ASSISTED 160,000 RURAL HAND TUBEWELL PROJECT:

This is the biggest Rural Water Supply Project ever the United Nations Children's Fund took up anywhere in the world. In this project DPHE could sink average 8000 wells per month. Never before DPHE took up such a gigantic project. How could we do it? Because during implementation we prepared a time schedule (in line diagram) of different events of the project such as mobilization of materials, recruiting and mobilization of man-power and arranging training facilities for them, preparation of specifications and even enlistment of contractors, time to time evaluation of works, modification of method of work and management of works, modification in the use of materials through pilot projects and research both for projects and future operational facilities, modification in the management of operation and maintenance etc. In the annexure A, a line works schedule which has been adopted in the above project has been shown. A new-work analysis of work schedule taken from WHO Public Health paper No. 59 is annexed in B. It will not be difficult for you to understand them.

Implementation of a project is completed when it is brought to the point of operation. Training of operational staff is therefore, a part of the project, otherwise for want of operators the facility may be idle. This is very true for urban water supply project as well. The water works superintendent and the pump operators should be recruited and given training simultaneously either in the job or outside.

While planning a project, type and strength of man-power required should be analysed and projected as such. Otherwise project implementation would be strenuous, delayed and defective.

Without vision and without methodology, nothing can be achieved. This is true in all walks of life. From the President of a Country to a day labourer everybody desires that his son should be a learned man and well established to earn a reputation in the society. This is a project requiring methodical programming of multifarious events and activities of discipline.

That is, the son should be a boy of good character who minds his studies, keeps wide outlook to serve the nation and the people, develops proper human relations etc. etc. This is a long-term project of about 20 to 25 years of time and a space say 16 steps of a ladder within this period of time. During this time-space he should complete his education and also develop all the above qualities. The father is the head of the family administration who should manage and generate all of the above qualities in the mind of the boy. If he fails the son may not reach up to that level. So desire is one thing and achievement is another thing. Whatever resources you have got unless you are methodical you cannot accomplish anything.

8. <u>OPERATION & MAINTENANCE:</u>

It has already been said that outputs of DPHE Projects are not only limited to produce a good number of quality works but also their uses. The time and money invested in a DPHE Project can be completely wasted if the system is not used by the local people. Therefore careful planning, project implementation and constant evaluation is necessary to remodel the system to suit the people; because the behavioural patterns of the people cannot be changed overnight. This is true for village latrine. Constant health education through discussion with village people, prepared lectures to school children, demonstration at work site and propaganda through leaflets, booklets and film shows play the most important part.

Regarding maintenance of rural water supply system it has become a headache for all due to insincerity of many of the mechanics who do not repair tubewells with zeal and dedication. It needs now, not only to follow-up and control over their activities but also imbibe in them true human element of service to mankind.

In fact, it is impracticable, if not impossible to look after activities of 1644 mechanics who repair about 200,000 tubewells spreading over the entire area of 55,200 sq. miles of Bangladesh by 164 Sub-Assistant Engineers and 62 Assistant Engineers in addition to their other normal jobs. The method of management needs a thorough change.

Recently mechanics have been placed under the control of Chairman U.P. to report for their activities. But dual control does not work smoothly as it was experienced previously. Therefore it has been suggested that mechanics would be placed under direct control of the Chairman U.P. Each union shall have one mechanic. The present system is the first step towards that end in view.

For health education to the people, better supervision of works and superior supervision of maintenance, collecting statistical data for depth - quality relationship of wells for economical sinking, and monitoring, DPHE felt it necessary to expand and establish its offices in Thana Headquarters under one Sub-Assistant Engineer. If that is done then DPHE Engineers would be in a position to take care more closely in social intervention programme.

9. CONCLUSION:

The present state of health of the people of Bangladesh is a challenge to the Sanitary Engineers. Our ultimate goal is the betterment of human health which in turn incfeases man-power and wealth of the nation.

The DPHE engineers are quite different from engineers of other organizations. We are to deal with dynamic problems of social system not the static steel frame structures. So, to work in this human medium responsibly and capably it requires continuing flexibility and adaptation to adopt methods compatible to human behaviour. It needs leadership and alertness for tackling and solving a problem, and for decision making. It is different from working out stereotyped projects by following written documents and directives.

The benefits the DPHE engineers can give to the nation are intangible. Therefore their existence, in the language of poet 'Grey' is, "Many a flower is born to blush unseen". But their reward then is to see the people healthy.

This network method is called CPM (Critical Path Method).

Network analysis is a set of concepts for scheduling and controlling time and activity and can be accomplished with an understanding of the following 10 definitions:

1. Activity - Time consuming effort or work necessary to proceed from one 'event' to the next.

2. Event or milestone - A point in time that coincides with the end of an activity - or the start of the next one - but that does not consume time.

3. Network - A diagram depicting the activities and events of a project so as to show their relationships in time. Fig 1 is an example.

4. Slack - The time difference between the time an activity must be completed (latest time) and the earliest time an activity could be completed.

5. Elapsed Time - Total time required to complete an activity (including idle time).

6. Expected Activity Time (t_e). - The number of elapsed time units that an activity is expected to require.

7. Expected event time (T_E) - The total number of time units required to reach an event.

8. Latest Allowable Completion Time (T_L) - The latest time by which an event has to occur if there is not to be a delay in completing the project.

9. Event Slack (S_E). - The amount of acceptable delay available in reaching each event.

10. Critical Path - The series of events in which there is no slack.

For a project schedule in CPM method the following procedure may be followed:

(1) Listing of events

   (a) Identify events.

   (b) List events

   (c) Determine inter-relationship in time.

(2) Computed network diagram.

(a) Draw the network

(b) Estimate activity time (t_e)

(c) Determine expected event completion time (T_E)

(d) Determine the latest allowable completion time (T_L)

(e) Determine event slack (S_E) and critical path.

(f) Revise the network and recompute as necessary.

(g) Convert T_E's and T_L's to Calender dates

Computed Network Diagram

(a) Identify events and their time inter-relationship and then draw network.

(i) Events are depicted as circles or squares. The beginning event appears at the left side of the network and the completion event at the right side.

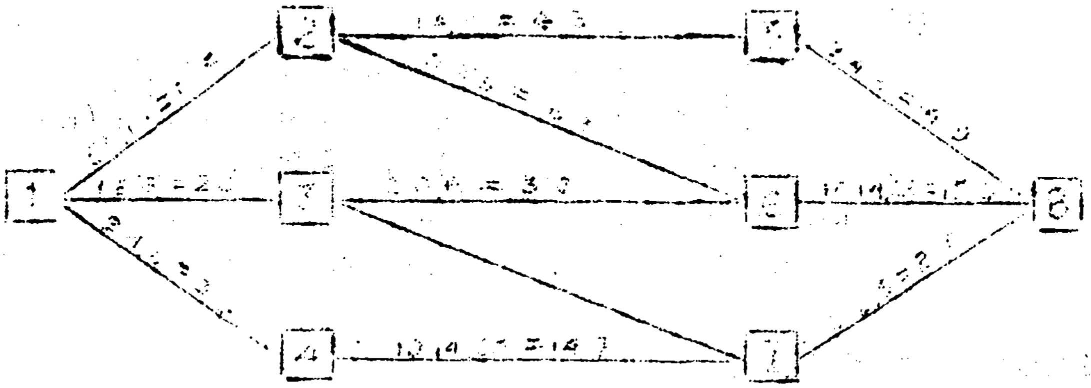
(2) Lines are used to depict the activities that lie between events.

(3) First put the events and activities arbitrary. Ultimately put them in time scale.

(b) Estimate activity time (t_e) in the following manner.

(1) It is customary to use 3 time estimates in working out the probable completion time of each activity. These are optimistic time (denoted by a), passimistic time (denoted by b), and the most likely time (donated by m).

The, $T_e = \frac{a + 4m + b}{6}$



Calculation of te

Fig I

(2) **For ease of computation of t_e's, a computation table may be set up.**

Activity	a	m	b	te.
1-2	5	6	10	6.5
1-3	1	2	3	2.0
1-4	2	4	5	3.8
2-5	1	4	9	4.3
3-6	2	3	6	3.3
etc.				

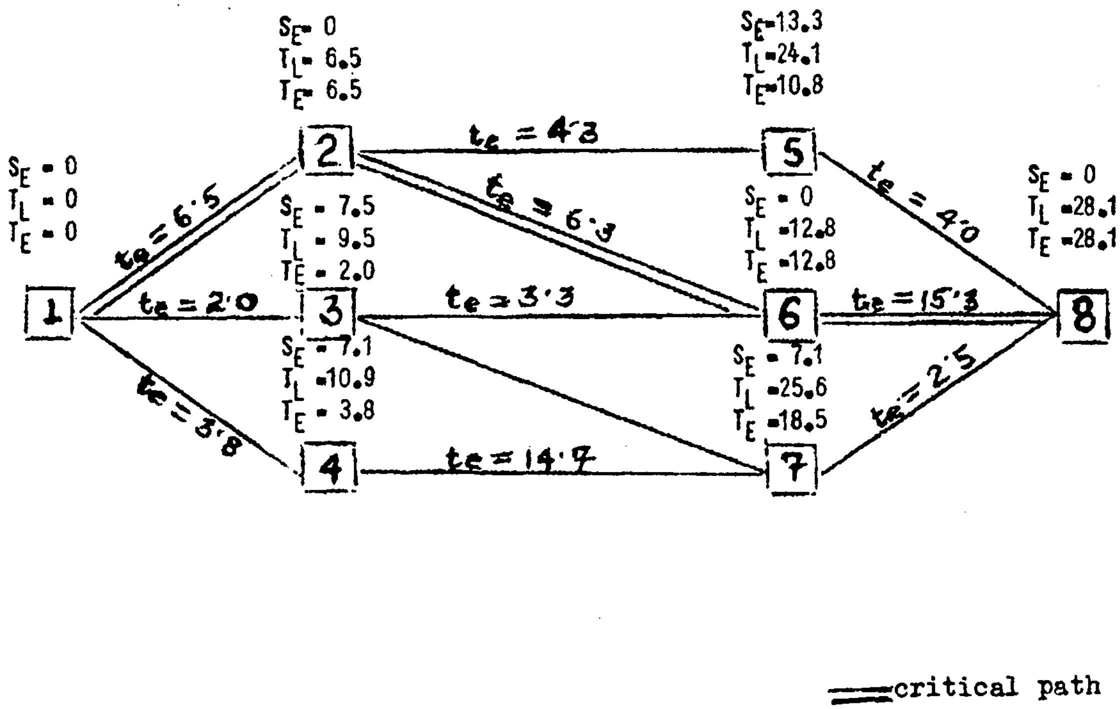
(c) Determine the expected event completion time as shown below.

(1) Work forward through the network using simple addition of t_e's, to determine the elapsed time needed to reach each event and write each sum above the event as, eg., T_E = 6.5 for event 2 (Fig 2).

(2) The addition is cumulative, since no event can be reached until all necessary proceeding events and activities have occurred.

(3) Whenever an event depends on more than one path, always select the path that consumes the maximum time. Example: in case of event 7, T_E is 18.5 (Fig 2) by following path 1-4-7 which is most time consuming than the path 1-3-7.

This procedure also identify the project completion time.



Calculation of T_E, T_L, S_E and critical path

Fig 2

(d) Determine the latest allowable completion time (T_L). T_L of each event is calculated by subtracting the t_e of the following (right-word) activity from the T_L of the following (rightward) event. Thus in (Fig 2) the T_L of event 5 is obtained by subtracting the t_e of Activity 5-8 from the T_L of Event 8 (28.1). The result (T_L = 24·1) is then written above event 5. When an event relates to more than one subsequent (rightward) activity, subtract the more time consuming t_e. Thus T_L of Event 3 is obtained by subtracting the t_e of Activity 3-6 (3.3) from the T_L of Event 6, not the t_e of Activity 3-7 (2.3) from the T_L of Event 7. The T_L of Event 3 is thus 9.5

(e) Determine event slack (S_E) and critical path.

(1) Subtract the T_E from T_L of each event and put the result S_E of each event: S_E represents the amount of acceptable delay in reaching that event without jeopardizing the project completion

(2) Some events will be found to have an S_E=0. The path that connects these events having S_E=0 is the critical path, which represents the line of activities in which no delays are tolerable if the project is to be completed in time. In Fig 2, activities 2-6 and 6-8 are critical path.

(f) Revise and modify the network. Review the S_E entries and critical path for any possible revision, such as:

- Transferring resources of activities so as to complete the project earlier.
- Achieving an earlier completion time by engaging more resources to the critical path activities (thus reducing their t_e)
- Altering strategy for recomputation of the network.

(g) Calendar tabulation for project control.

(1) Starting from the event(1) determine the date for each T_E and T_L in the network.

(2) Set up a table of activities in the order of successive dates of the T_L's.

Summary:

In summing up the whole network of a project we find here 8 events. Event 1 is the starting point with zero time. And event 8 is the completion event of the project with time T_E, say 28.1 months. This is also the latest allowable time T_L. T_E has been calculated through the most time consuming activities of the events which are 1-2-6-8.

In the network, successive events are dependent on one or more events which are, in Fig 1.

events 2, 3, 4	depend on	event 1
event 5	depends on	event 2
event 6	depends on	events 2, 3
event 7	depends on	events 3, 4
event 8	depends on	events 5, 6, 7

To see how events are interdependent let us take a hypothetical case say, Urban Water Supply Scheme of Gopalganj Town.

The works must be completed and brought into operation within about 2 years time, it is said. The ground water explored earlier which contains too much iron and need treatment plants.

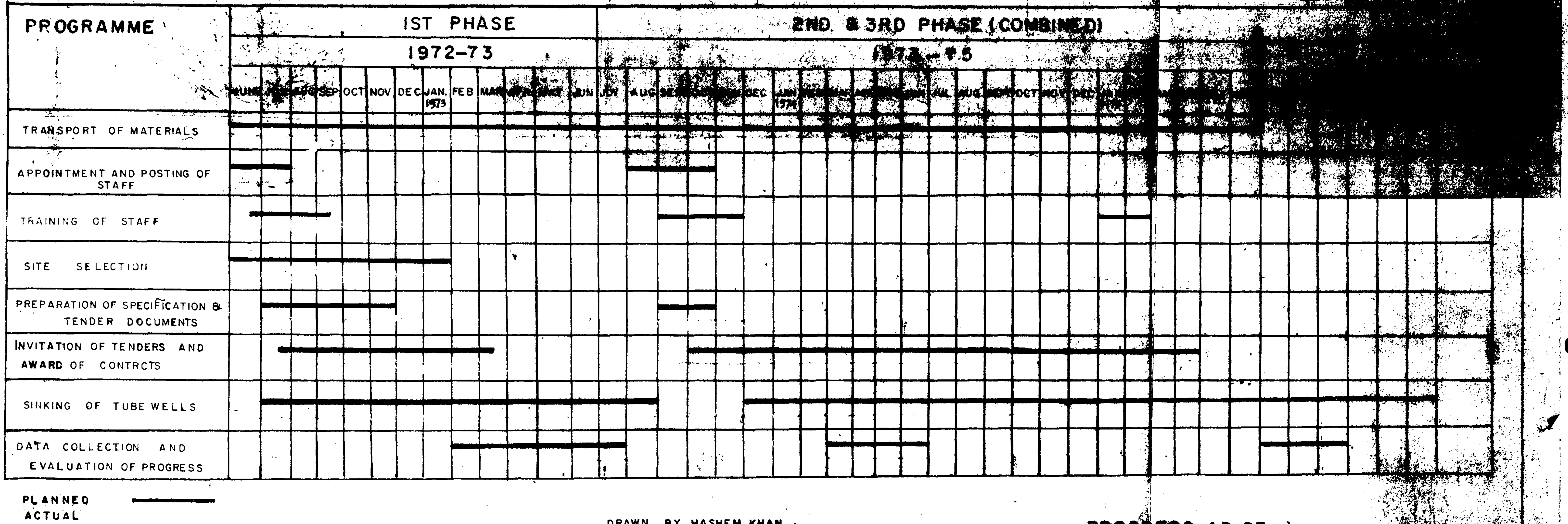
Starting works (event 1) from 1 August 1973, the activities are arranged as shown below:

Activity No.	Activity Description	Activity Time (t_e)	Date Expected (T_E)	Latest date Allowed (T_L)	Slack (S_E)
1-2	Survey and preparation of maps. Design of piping system. Design of treatment plants.	6.5 months	15 Feb. 1974	15 Feb.1974	0
1-3	Mobilization of materials	2 "	1 Oct. 1973	15 May,1974	7.5 month
1-4	Design of pump house and Elev.Tank and calling tenders. Sinking production wells	3.8 "	Nov. 1973	June,1974	10.9 "
2-5	Preparation of specification & drawing and calling tenders for piping system.	4.3 "	June, 1974	Aug. 1975	13.3 "
2-6	Preparation of specification and drawing for treatment plants and calling tenders	6.3 "	Sept. 1974	Sept.1974	0
3-6	Mobilization of materials	3.3 "	Sept. 1974	Sept. 1974	0

Cont'd

Activity No.	Activity Description	Activity Time (t_e)	Date Expected (T_E)	Latest date Allowed (T_L)	Slack (S_E)
3-7	Recruiting and on the job training of Water Works Superintendent and pump drivers	2.3 months	Feb, 1975	Sept. 1975	7.1 months
4-7	Construction of Elev. Tank, pump houses and installation of well pumps.	14.7 "	Feb. 1975	Sept. 1975	7.1 "
5-8	Execution of piping system	4.0 "	Dec. 1975	Dec. 1975	0
6-8	Execution of treatment plants	15.3 "	Dec. 1975	Dec. 1975	0
7-8	Power connection with pumps and test pumping	2.5 "	Dec. 1975	Dec. 1975	0

PROGRAMME AND PROGRESS SCHEDULE (2ND. REVISION)
DPHE UNICEF PROGRAMME OF 160,000 HAND TUBE WELLS 1972-75



DRAWN BY HASHEM KHAN
25-2-75

PROGRESS AS OF...

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: ROLE OF W.H.O.

V. P. N. Nayar
W.H.O. Sanitary Engineer
Dacca

March, 1975.

ROLE OF W.H.O.

1. INTRODUCTION:

The WHO is one of the several specialized technical agencies under the United Nations Organization. The WHO and Bangladesh concluded a basic agreement in the year 1972. Since then, under the dynamic leadership of Dr. Sam Street, WHO Representative in Bangladesh, various programmes are being taken up for the general improvement of health of the large population of Bangladesh, although the major one among them is eradication of smallpox. The WHO is also very much concerned with family planning, strengthening of health services, man-power development, etc. The promotion of environmental health is of particular concern in the context of the heavy incidence of intestinal diseases in Bangladesh. It is estimated that more than 50% of cases of mortality among infants in Bangladesh are due to diarrhoeahldiseases. About 10,000 babies are born everyday in Bangladesh and with the present rate of infant mortality of 140, the situation is something very serious.

2. POPULATION AND HEALTH STATUS:

Bangladesh is perhaps the most thickly populated country in the world with an estimated 71.32 million population as in February 1974 of which about 94% live in the rural areas in some 64,000 villages. At the present rate of growth of population (3.1% per annum), it is likely that the population will be doubled by the year 2000 A.D.

Waterborne diseases prevalent,mostly cholera, dysentery, diarrhoeah and other parasitic diseases are almost endemic in Bangladesh. Much of the incidence of these diseases is attributed to insanitary living conditions.

3. ENVIRONMENTAL HEALTH:

Environmental health covers to say the least the following:

Water supply, sewage treatment, solid waste disposal, the control of diseases vectors, control of air and water pollution, radiation protection, industrial hygiene, etc. etc. Among these, the most important are protected water supply and safe disposal of excreta. In the South East Asia Region of the World where probably almost 60% of the population on the earth live, the conditions regarding sanitation both from lack of water supply and excreta disposal, are more or less similar. While in the industrially developed countries of the West, both these have been met to a very large extent by the provision of safe water supply and proper collection and disposal of human wastes, comparatively little attention has been paid in meeting those health hazards in this region. Human excreta is the principal source of pathogenic germs carried by water, food and flies. The latter constitute the major vehicle of transmission of diseases to man. Extensive pollution of the soil by solid and liquid wastes exposes entire communities to various faecal borne infections. To these are supplemented malnutrition and the consequences are incapacity to work not to speak of illness and eventual death in many cases.

We often find that priorities are seldom given to the required level for items like water supply and excreta disposal. Communications and housing including hospital beds, get a larger priority than for the effective drainage, collection and disposal of community wastes, etc. on the plea that the latter fields are too expensive. In fact, by suitable incremental planning, such schemes can be taken up and a permanent eradication of water-borne diseases achieved through the correction of the environment by practical applications of public health engineering principles which are essentially of a preventive nature. Curative services are always repetitive and in the long run prevention will be most economic, besides being a "once and for all" solution to the problem. In the developed countries of the world, diseases caused from insanitary and allied conditions are practically non-existent with the result the expenditure for curative services that would otherwise be necessary, can be diverted for various other health promotion programmes in the field of social welfare. The time has come when man cannot live any longer in health and comfort with his own wastes surrounding him. While the environment in the developing countries in relation to health is more concerned with water supply and excreta disposal, the developed countries are more concerned with industrial pollution, radiation hazards etc.

4. WHO ROLE IN THE PROMOTION OF ENVIRONMENTAL HEALTH:

WHO is a technical agency and has comparatively limited financial resources and therefore, its activities are confined to the fields like placement of technically competent long-term staff and short-term consultants in selected fields as required by member countries, supplies of essential equipments, reference books, laboratory supplies, etc. in specified fields of work. Granting of fellowships to nationals both for university education and for observation study tours to gain practical knowledge in selected fields is yet another. Sponsoring nationals for participation in seminars and workshops, developing information systems, promoting quality control, conducting national sector studies for initiating schemes which qualify for international and bilateral assistance in the country concerned are yet some others. WHO also assists in strengthening manpower in the field of environmental health by developing the faculty of public health engineering in Universities, Institutes of Technology, Para-Medical Institutions, etc.

5. CURRENT PROGRAMME IN BANGLADESH:

WHO is currently engaged here to assist the Directorate of Public Health Engineering in the implementation of the UNICEF aided rural water supply programme, the promotion of environmental health through the construction of sanitary latrines in rural areas, schools, etc., in developing the sanitary engineering faculty of the University, in initiating studies on garbage disposal for the cities of Dacca, Chittagong and Khulna, to develop a scheme for the conversion of dry latrines of Dacca city to flush toilets, etc. Besides, the WHO has been active in initiating and financing study tours and observation trips to selected personnel in various fields of environmental health as also in sponsoring candidates for short courses in community water supply and sanitation, in participating in inter-country seminars, etc.

6. PROPOSALS:

In the coming years in addition to those stated above, WHO proposes to further develop the scope for improving the conditions of sanitation both in the urban and rural areas. To be more precise, in as much as it may take several decades before proper arrangements of safe disposal of community wastes will become possible and in the context of the growing problems of conservancy system in towns, the WHO is possibly proposing to institute a pilot study on the ways and means of meeting these problems with some suitable interim measures.

7. CONCLUSIONS:

WHO's efforts may not be spectacular, but they are primarily responsible for initiating action in moving the Government to view the country's health in the larger prospective, to assign adequate priorities and thereby attract international and bilateral assistance and help the country to reach better levels of public health.

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : ROLE OF UNICEF

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MARCH, 1975

THE UNITED NATIONS CHILDREN'S FUND (UNICEF)

WHAT IS UNICEF ?

Assistant Engineers know of the UNICEF Organization. But many will not know much about its objectives, organization, what it is doing in Bangladesh and why it is here.

Origin - UNICEF was organised by the United Nations in 1946 to help the children of Europe affected by the Second World War. Later UNICEF was continued indefinitely to promote programmes which would help children in the developing countries. UNICEF have the special responsibility to care for children wherever care is needed.

Objectives - UNICEF take special note that the future of any country is to be found in the health of its children. If the children grow up without adequate food, clothing, housing, and education the country cannot expect that as adults they will be hard working, sensible and valuable members of society. Similarly, if through their childhood they are racked by diseases, worm infestations, and vitamin deficiencies, they cannot grow into strong adults. We want to avoid the loss of manpower caused by disease and malnutrition, but the reason that UNICEF receives such support is the feeling of sadness all men and women must leave when they see an innocent child, too young to understand anything about the world but already doomed to a life of hunger, disease, and hopelessness.

UNICEF is interested in helping countries take care of their children, their most valuable resource and the future citizens and leaders of the country. The first objective is to build up organizations and install systems which will protect the health of children. But when emergency situations occur UNICEF are prepared to help in whatever way is necessary.

For example if a flood occurs and poor people are forced to take refuge in a relief camp UNICEF are prepared to help install a tubewell to provide relief for the victims. But UNICEF would prefer to install a well in the village area so that the people will always obtain the benefit. Most of all UNICEF would like to help build up the DPHE organization so that it can obtain the resources necessary to finance and install tubewells without any UNICEF assistance whatever.

Area of Work - Bangladesh is only one of over 100 developing countries where UNICEF provide assistance. The type of assistance changes with the condition of the country. For example in the rich oil producing countries the assistance may be key experts paid for by the country itself but recruited by UNICEF. In moderately wealthy countries loans are given to support development works. In the case of Bangladesh, which has suffered severe misfortune, assistance is given as a gift but the projects are done in cooperation with the Government of Bangladesh which then provides for the local cost of the construction work and for the cost of the extra staff required to do the work.

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UNICEF Finance - UNICEF is financed by Voluntary contributions. This means that Governments and individuals decide the work UNICEF do is worth supporting and contribute money to help the work. In 1974 UNICEF received the equivalent of about Tk. 60 crore to help mothers and children in over 100 countries. UNICEF have been able to attract larger cash donations each year because the donor countries recognise that UNICEF is doing a good job to help mothers and children throughout the world. It should be noted that of the total of Tk. 60 crore for 100 countries, Tk. 8 crore has been spent on the DPHE/UNICEF rural water supply programme in 1974.

It can therefore be seen that the handpump tubewell programme in Bangladesh is the largest UNICEF supported water supply programme in the World. We should also note that this makes for a special responsibility to see that the money is properly used. If resports of misuse of UNICEF materials in Bangladesh were to reach the donor countries the total amount of money donated to UNICEF could be greatly reduced and children all over the world would suffer as UNICEF programmes would have to be reduced.

WHAT IS UNICEF DOING IN BANGLADESH ?

UNICEF have six main programmes in Bangladesh.

1. Short term relief projects which are being phased out, such as :-

   a) Child Feeding - the distribution of foods donated by the United States.

   b) Cloth distribution.

   c) Import of medical supplies

2. The rural water supply and sanitation programme - described later

3. Child health programme - assistance to national health services such as:

   a) Providing equipment and transport.

   b) Providing drugs, equipment for medical schools, a plant to produce fluid for people affected by cholera.

4. Education - Supply of materials for primary school construction, supply of equipment for primary and secondary schools and teacher training schools.

5. Nutrition - Projects to improve the availability of protein by cultivation of higher yielding breeds of fish.

6. Social Welfare - Helping unemployed and destitute people.

   All of these programmes help the people of Bangladesh in different ways. But in all cases the assistance given is in accordance with the wishes of the Bangladesh Government. At present the scope and direction of UNICEF projects is under review as detailed later.

THE UNICEF/DPHE WATER PROGRAMME

A most unusual programme

The joint UNICEF/DPHE water programme is a most unusual programme. Bangladesh citizens who have spent all their life in the Bangladesh are often not aware how different Bangladesh is from most other parts of the world. Bangladesh is a land of rivers. Rivers formed the country over thousands of years gradually building layer on layer of silt and sand on the bed of the Bay of Bengal until slowly the land rose from the sea. For this reason a well can be sunk 1000 feet in the coastal areas and never hit a stone or rock or anything larger than a grain of sand. In most other parts of the world, stones, large boulders and solid rock may be found a few inches or a few feet below the surface. Because there are only alluvial materials over most of Bangladesh it is possible to sink wells by simple cheap drilling methods. Because much of Bangladesh is flooded every year and water seeps down into the ground, the wells may be pumped without fear that one day the water will all be used up.

And so the rivers and floods which so often cause problems for Bangladesh also give a great opportunity to supply a large number of people with good health preserving water at quite a low cost.

The basic programme of assistance includes :

Item 1. The installation of 1175 deep wells and 500 shallow wells in the coastal areas.

Item 2. Provision of spare parts for maintenance of 125,000 existing public handpump tubewells.

Item 3. Installation of 100,000 new tubewells and resinking 60,000 choked up wells.

On completion of the current programme in 1975 UNICEF hope to support the following :

Item 4. Installation of 155,000 additional shallow wells between 1975 and 1978.

Item 5. Construction of 5,000 more deep wells between 1975 and 1978.

An important programme

The connection between health and the use of clean drinking water has been discussed. Children are the ones most likely to die or get sick from drinking dirty water. This is true everywhere and in other countries wells are sunk at great expense through hundreds of feet of solid rock. But here in Bangladesh a well can be sunk to a depth of 150 feet (the average depth of wells in Bangladesh) for Tk. 500, plus the materials cost which UNICEF can purchase for less than Tk. 1000. For a total of Tk. 1,500, a well of average depth can be installed. If this is a public well used by 100 people the cost per person is only Tk. 15. If the well is private (used by 10 people say) the cost is Tk. 150 per person.

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For this reason UNICEF agreed to supply materials for public handpump tube-wells. When 325,000 wells have been installed UNICEF will have helped install one well for every 250 people in Bangladesh. Added to the existing public and private wells there should be one well for every 125 to 150 people in Bangladesh. This would mean that perhaps 1/3 of the people would have easy access to a well and over half the people can find well water without too much effort if they wish.

We cannot say exactly how many children who would otherwise have died from cholera or other water borne diseases will not die because of the handpump tubewell programme. We cannot say how much distress and sickness the programme will save, and we cannot estimate how much time will be saved by having a clean and pleasant source of water near a home. But we are convinced the rural water supply programme is an excellent programme, unique in Asia and well worth the money of the Government of Bangladesh, and UNICEF, and efforts of DPHE staff and UNICEF staff.

How UNICEF take up a new assistance scheme

At present UNICEF are considering plans, discussing with the Government, and estimating expenditure for future involvement, in the following areas :-

Food for food production programmes;

Tank reconstruction and fish cultivation;

Irrigation tubewells;

Rural sanitation;

School hostel accomodation;

Family Planning;

Health;

Educational reorganization;

Many other projects.

How and to what extent UNICEF become involved in these works will be decided in the coming months by decision of (a) The Government and Government Departments (b) UNICEF Bangladesh (c) UNICEF Executive Board and (d) the generosity of foreign aid donors.

The steps in Bangladesh by which a scheme is taken up by UNICEF is generally as follows:

A need is identified, which affects the lives of mothers and children, and in which UNICEF can help the Government do whatever is necessary. Identification of this need may be either by UNICEF staff in Bangladesh or by a Bangladesh citizen acting in his private or public capacity.

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Discussions and consideration would then follow in which the size, shape and cost of possible UNICEF assistance, is discussed. At this stage, the UNICEF programme officer would play the main part in suggesting how UNICEF may be able to help. There is no point in putting up projects which cannot be seen to help mothers and children fairly directly. UNICEF are interested in projects which appear to have a good choice of practical success and whose effects will be continuing. The choice of practical and successful projects is of vital importance to UNICEF.

Once UNICEF in Bangladesh have decided a project is worthwhile and practical, it then becomes necessary to obtain the necessary support from the UNICEF Executive Board who have control of what projects to finance. A written request from the Government to support a project is required. A detailed proposal of what the project entails is then prepared by UNICEF Dacca for discussion with the UNICEF Board. After discussion a final proposal is prepared. The UNICEF Board sit annually to consider the various projects from various countries and decide whether to support the project or not. Decision is based on how practical the scheme seems, how much importance the Bangladesh Government attaches to the scheme (the Government financial contribution to the work is a measure of the importance they attach to it) and how much money is available for expenditure in Bangladesh. Sometimes a project fits all the requirements but UNICEF just do not have enough money to finance the scheme. They may then issue a request to foreign governments for support on that particular project. Such a situation occured with the last 55,000 wells of the current 155,000 well project. The Danish Government agreed to provide $ 3.3 million over four years to provide the necessary materials. At present we find the cost has doubled and we may have to approach the Danish Government to ask whether they will pay a further $ 3 million to continue the project as planned. The Danish Government have representatives in Dacca and visiting aid representatives and you may be sure they will inspect some wells, read the newspapers and talk with people here to decide whether this work is worth extra support. It is therefore important that the work is done properly at a reasonable speed and honestly, if it is to continue with full support from all donors.

Once a scheme is financially approved a Plan of Operations must be prepared and signed by the main parties - UNICEF the Government and in the case of the water programme the W.H.O. In emergency situations this procedure may be waived, and in fact the Plan of Operations for the first 160,000 well programme was signed long after the start of the project. However, this will not apply for the next project of 155,000 wells.

Once a project is approved the UNICEF programme officer has some flexibility within the project. For example if money was approved for jeeps and motorcycles he may decide to use the money all for jeeps, all for motorcycles or not at all as he thinks fit. He may also decide that boats are more needed and without too much trouble change the order accordingly.

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<u>Practical Effect</u> : The effect of these conditions is that all UNICEF programmes and parts of programmes <u>must be considered in the light of their benefit to mothers and children.</u> It may be difficult to determine whether milk powder or tubewells will in the long run benefit children most. In an emergency UNICEF might go for milk powder. In more settled times for tubewells. Having gone for tubewells it is fairly easy to show that motorcycles and vital DPHE stores construction will help the tubewell programme. But it becomes difficult to demonstrate that DPHE office building and Assistant Engineers quarters are more important to children than milk powder ! Accordingly UNICEF must limit involvement with the DPHE to works which will clearly help the programme.

UNICEF INVOLVEMENT IN THE HPTW PROGRAMME

Size of the programme - To give some idea of the size of the programme the following figures are quoted :

Length of pipe ordered for 160,000 wells	: 20 million ft (2 crore ft.)
Total number of screens ordered	: 325,000
Bags of cement imported	: 230,000
Cost of UNICEF commitment 1974-78	: $ 19 million (Tk.150 million)

(Costs have now risen to over $ 25 million)

In addition UNICEF recently received 6,600 tons of pig iron to manufacture pumps. The above quantities are the materials required for wells to be built by June 1975.

Plan of Operations

The Plan of Operations is the document jointly signed by the Government of Bangladesh, UNICEF and World Health Organization which details the responsibility of each. The document is 30 pages long and we have no time to study it all in this lecture but some of the main points are picked out below:

The Government, UNICEF and the World Health Organization agree that :-

1. The objects of the project are to improve the health of the people; to develop a better handpump; to make the people more aware of the importance of clean water and try to obtain their cooperation in well construction and maintenance; and find some way to improve well maintenance.

2. Tubewells must be allocated fairly and so that all people may have access to the wells. Wells must not be in private compounds. They are not intended for Government officers quarters, police stations and similar institutions. Top priority goes to populated areas where there is no tubewell at all.

3. UNICEF representatives shall have the right to request re-allocation of sites not conforming to the agreed site selection criteria. They shall have access to site lists and shall be helped to visit sites to check that the criteria have been followed.

4. Additional PHE staff shall be recruited trained and posted to supervise the work. Total staff should include 75 Assistant Engineers, 148 Sub-Assistant Engineers/Overseers, and 1644 Mechanics. Additional staff shall be employed as necessary.

5. Contractors appointed shall be competent to do the work and reliable. After each phase of the work the contractors shall be evaluated.

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6. Sub-Assistant Engineers shall check all completed wells and Assistant Engineers shall check at least 10 percent of such wells.

7. UNICEF field staff shall inspect PHE Sub-divisional stores and ledgers monthly. Superintending Engineers shall be responsible for continuing evaluation of the programme within their respective circles.

8. UNICEF will supply pipes, screens, pumps and cement for the wells to be constructed under the programme.

9. UNICEF will import maintenance spare parts for the period 1 January 1972 to 30 June 1974.

10. UNICEF shall have the right to request the return of any equipment or supplies furnished by it which are not used for the purpose of the Plan of Operations.

11. The Government shall pay all local costs and local materials, and shall provide the necessary staff.

12. The Plan of Operation may be modified by mutual consent of the Government, UNICEF and WHO.

THE IMPORTANCE AND ROLE OF ASSISTANT ENGINEERS

Over the next three years the equivalent of approximately US $ 40 million will be spent on the rural water programme. That is over U.S. $ 500,000 for each Assistant Engineer. On average each Assistant Engineer will be in charge of an area in which 3000 wells will be built which will supply between $\frac{1}{4}$ million and $\frac{1}{2}$ million people with clean water. At the same time he will be responsible for the maintenance of about the same number of old wells supplying about $\frac{1}{2}$ million people with water. It therefore follows that with hard work and dedication the Assistant Engineers DPHE singly and collectively over the next three years will have an opportunity raise and maintain the health of a significant portion of the nation. Just what his responsibilities are and how they should be exercised will be covered elsewhere in this course. But in summary we hope Assistant Engineers will have the following qualities:

(a) They work intelligently and honestly. They see what the objectives of the programme are and they will strive to get the work done as well as possible.

(b) They will act as leaders. By their example and discipline they will demonstrate the proper approach to work.

(c) They will act fearlessly and speak out when it is necessary to speak out.

The cooperation between DPHE and UNICEF staff and Summary

UNICEF field personnel have an overlapping duty with DPHE personnel. While the Assistant Engineer represents the Government of Bangladesh and has the duty to make sure the Government gets what it pays for. UNICEF staff represent the United Nations and the foreign governments and individuals who have given money in the confidence that it will be used to help children grow up healthy.

Both DPHE and UNICEF have the same objective to see good wells built to help the common people. Therefore it is right that UNICEF staff and DPHE staff should cooperate to get good wells. UNICEF staff should not do their work with the objective of showing up the faults the DPHE. We all realise field inspection work is not easy in the conditions of Bangladesh. Therefore UNICEF look to the Assistant Engineer to help them carry out their duty. Notify them of well sites, and if necessary accompany them on visits. In return UNICEF will inform the DPHE of faulty wells discovered, and help the implementation of the programme in whatever way they can.

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S U M M A R Y

UNICEF is an agency of the United Nations with a special responsibility to help children. UNICEF assist many kinds of projects in over 100 countries.

UNICEF have spent crores of Takas to help the DPHE in Bangladesh.

The UNICEF/DPHE programme is planned to continue through to 1978 at least. The programme is a very good one. Millions will benefit from the pure water available from handpump tubewells.

UNICEF wish to continue the programme but have a duty to see that UNICEF funds are properly spent. The Government of Bangladesh has agreed to meet its obligations under the Plan of Operations.

Assistant Engineers are essential if the work is to be carried out properly and the people are not to be cheated.

UNICEF staff and DPHE staff wish to see good wells and should therefore cooperate to see that Contractors do good work.

Lastly, UNICEF are proud to work with the DPHE on this excellent project which is bringing relief and better health to millions of people in Bangladesh. DPHE staff and UNICEF staff are to be congratulated on their good luck to work on this project at this time.

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TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : BASIC INFORMATION ON GROUND WATER

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MARCH 1975

1. INTRODUCTION:

Ground water is an important source of water supply throughout the world since it constitutes the largest available source of fresh water. The continued increase of demand for water throughout the world has also stimulated the development of under-ground water supplies. As such knowledge of occurence and movement of ground water, better means of extracting ground-water etc. is essential for effective use and management of the ground-water resources and with more attention to ground water utilization, the knowledge of ground water hydrology, once veiled in mystery, has also expanded rapidly in recent decades.

2. OCCURENCE OF GROUNDWATER:

Ground-water occurs as part of the hydrologic cycle. The hydrologic cycle or the water cycle is the continuous circulation or movement of water. It is the chain of events that describes the cycle through which water moves from ocean to atmosphere to land and back to the ocean. The water from oceans and lands is evaporated and goes into atmosphere where it condenses and falls back either on land or sea as rain, sleet, snow etc.- various forms of precipitation. Precipitation that falls upon land is essentially the source of fresh water supply. Some of it then flows over land surface in the form of surface runoff and ultimately goes into ocean. The intercepted water in natural reservoir, transpired water and part of surface run off return to atmosphere by evaporation and evapo-transpiration. The rest of precipitation infiltrates through the ground under gravity and reaches the zone of saturation to form ground-water reservoir. The ground water later reappears as base flow into streams, lakes or appear as springs, eventually leading back to ocean and completing the cycle.

3. SUB-SURFACE DISTRIBUTION OF WATER:

Water that infiltrates the soil is the sub-surface water. The sub-surface ground-water is categorised into zone of aeration and saturation. The upper strata of soil which is partly filled with water and air is called the zone of aeration, which is again sub-divided into sub-zones; soil-water zone, intermediate zone and the capillary zone.

In the zone of saturation all the interstices are filled with water under hydrostatic pressure and the water occupying the voids (spaces in the grains of soil) in the saturated zone is called ground water. The saturated zone is bounded at the top by either a limiting surface of saturation or an impermeable strata and extends down to underlying impermeable strata such as clay beds or bed rock. In the absence of an overlying impermeable strata, the upper surface of zone of saturation is the water table.

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4. GEOLOGIC FORMATIONS AS AQUIFER:

A rock formation or strata which will yield significant quantities of water has been defined as an aquifer. To qualify as an aquifer, as such, a geologic formation must contain pore or void spaces filled with water and these openings must be large enough to permit movement of water through them to wells or spring at a perceptible rate. Thus an aquifer performs two important functions : a storage function like a reservoir and a conduit function as a pipeline.

Any type of rock, igneous, sedimentary or metamorphic may be an aquifer if it is sufficiently porous and permeable. Sedimentary rock which constitutes only 5 percent of earths crust contains 95 percent of the ground water and probably 90 percent of all developed aquifers consist of unconsolidated sedimentary rocks mainly gravel and sand.

5. GEOLOGIC INFORMATION ON BANGLADESH:

The surface of Bangladesh is characterized by the uniformity of a wide alluvial plain. Except in the south and north eastern portions where small hills are located the land is flat throughout. The elevation of land rises to only 30'ft. over the sea level even at a distance of 100 miles north from the sea. The land has been formed by the mighty rivers; the Brahmaputra the Ganges & the Meghna. The alluvium extends to different depths depending on the physiography of the area, but generally increases in depth in the south and extends to several thousands feet in depth.

(a) The first physiographic unit comprises the areas of Rajshahi - Bogra and Rangpur - Dinajpur which is under lain by basement rock at different depths. This is dated to have been formed in the Cambrian period (600 million years) and is generally made of volcanic and metamorphic rocks. In Ranipur area of Rangpur this rock is only at 600 ft. depth whereas in Bogra (Khanjanpur) the basement rock has been located at 3000 ft. depth. The whole area has later been covered by sediment deposits during the recent epochs.

(b) The second physiographic unit is comprised of the hills of Chittagong, Chittagong Hill Tracts in the south east and part of the Sylhet district in the northeast. These hills are a continuation of the hills of eastern India and are believed to have been formed in the middle Miocene period (15 million years). Geologists believe that this whole area was under sea during the Eocene (70 million years) period and probably the sea was shallow near the Sylhet area where large deposits of limestone is found. The Chittagong Hills are highest in Bangladesh, the highest peak being keokradang (4034') near Burmese border. These folded ranges run parallel to each other in a north-south direction.

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(c) The third physiographic unit of Bangladesh is comprised of three alluvial terraces in three different parts of the country. These are the Dacca-Mymensingh Modhupur tract, Lalmai Hills near Comilla and the Barind tract of Rajshahi-Dinajpur area. Geologists believe that the terraces which are higher by 20 to 100 ft. above the alluvial plain are product of heavy deposition by streams (Brahmaputra and its tributaries) during the pleistocene (1 million years) period. The total area being about 5000 square miles with its reddish soil is not flooded during monsoon due to its higher elevation.

(d) The fourth and the major physiographic unit of Bangladesh is the flood plain. The uniform and expansive flooded plain of Bangladesh is formed by the annual deposits of alluviums brought down by the three great river systems of the region. The average elevation of this alluvial plain is less than 30 ft. The actual gangetic delta is located in the south western part of the country where the delta building process is still very active. Most of the areas of Khulna, Barisal Patuakhali and Noakhali have been formed by very recent alluvial deposits.

6. TYPES OF AQUIFER:

An aquifer may be classified as water table or as an artesian type.

A water table aquifer also termed as an unconfined aquifer is one in which ground water possesses a free surface open to atmospheric pressure. Thus the upper limit of an unconfined aquifer corresponds to the water table and as such the water level in a well drilled in such an aquifer will reveal the upper surface of the zone of saturation, i.e. the water table.

An artesian aquifer also known as confined aquifer or pressure aquifer is one which is confined under pressure greater than atmospheric by overlying relatively impermeable strata. The water level in a well penetrating a confined aquifer defines the piezometric surface at that point. Unlike water table aquifers, the water level in a confined aquifer will rise above the bottom of the upper confining layer or impermeable strata to levels depending on the peizometric surface at that point. A confined well may be a flowing well, sometimes referred as spring well, or not,depending on the hydrostatic pressure in the artesian aquifer.

An aquiclude is an impermeable stratum which may contain large quantities of water but permitting in-appreciable movement of water. Clay is an example.

An aquifuge is a formation which is impermeable and devoid of water.

7. POROSITY AND PERMEABILITY:

Porosity represents the amount of water an aquifer will hold. It is expressed as percentage of void space to the total volume of the material. Porosity of a material depends on its shape, size, distribution, formation arrangement and degree of cementation and compaction. Porosity ranges from zero to more than fifty percent. Representative porosity of some sedimentary materials are given below:

Soil	- 50-60,	med. to coarse mixed sand	- 35-40
Clay	- 45-55,	fine to medium " "	- 30-35
Silt	- 40-50,	Gravel -	30-40
		Gravel and sand -	20-35

It is seen that clay has large water holding capacity, but because of its tiny open spaces, water cannot be transmitted readily and as such is not an aquifer.

The amount of water which can be drained from a medium is expressed as specific yield and the amount of water which is retained in the soil against force of gravity is the specific retention. Thus

porosity = sp. yield + sp. retention.

More important in ground water studies however, is the ability of a rock or soil to transmit water. This factor is known as permeability and is related not only to the void spaces in a rock but also to the degree of interconnection of these openings. Some factors pertaining to permeability and screen placement are given below:

i) Coarser sand is more permeable than finer sand, other factors remaining same.

ii) Uniform sand is more permeable than non-uniform sand, other factors remaining same.

iii) Presence of an appreciable percentage of flat particles (such a mica flakes) results in much greater lateral permeability than vertical permeability.

Thin lenses or stringers of clay in a sand section restrict vertical permeability but have little effect on lateral permeability.

iv) Both medium and coarser sands are suitable for strainer placement for gravel shrouded wells and also for natural development wells if the slot size is properly selected and the well is properly developed.

v) Aquifer containing fine sands are suitable for screening for gravel shrouded wells, however the shrouding material should be carefully chosen and placed.

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vi) It is advantageous to place screen in multiple aquifers if possible provided that the water quality is good in each aquifer screened since the specific capacity is increased.

vii) Care must be taken not to place screen opposite or closely below a section that contain silt or very loose fine sand which might flow into the well.

8. MOVEMENT OF GROUND WATER:

The ground water is constantly moving over extensive distances from areas of recharge to the areas of discharge. However the movement is very slow, which is governed by the permeability of aquifer and the hydraulic gradient. A normal range of velocities ranges from 5 ft./year to 5 ft/day.

Methods for determining these transmission rates are primarily based on the principles of fluid flow through a porous media, as represented by Darcy's Law. This states that the rate of flow through a porous media is proportional to head loss and inversely proportional to the length of flow. This is expressed as;

$$v = k \frac{hl}{L} \text{ or } v = kS \quad ....(1)$$

where, v = Velocity of flow, S = slope of the hydraulic

gradient, k = a co-efficient having same units as velocity.

To compute discharge, the equation can be written as,

$$Q = pAkS \quad ....(2)$$

where p = porosity of the media and A = gross cross - sectional area. By combining p and k.

$$Q = K A S \quad .... (3)$$

The term K is known as the coefficient of permeability, whose value depends on the characteristics of the porous media. Coefficient of permeability is usually expressed as the flow in gallons per day through a one square foot cross-sectional area under unit hydraulic gradient at 60^{o}F.

Permeability can be determined in laboratory by various types of permeameters. Field permeability can be measured by tracer movement or by pumping tests. Determination of permeability by pumping test is most reliable as it gives an integrated permeability value of a sizable aquifer in undisturbed condition. Typical values of coefficient of permeability ranges between 10000 - 100 for clean sand and mixture of clean sand and gravel, and for very fine sand, silts, mixture of sand, silt, clay the value ranges between 10 to 0.001.

Another term which is much used in ground water computations is the coefficient of transmissibility, which indicates the ability of an aquifer to transmit water through its entire thickness. It is equal to the average field coefficient of permeability of the entire aquifer multiplied by the saturated thickness of the aquifer in feet, $T = Km$ ....(4)

where, T = transmissibility of the aquifer, and m = saturated thickness of the aquifer. Thus introducing equation (4) into eqn. (2) we obtain, $Q = T \times \text{section width} \times S$..........(5)

8.1 Storage co-efficient:

When water is recharged or discharged from an aquifer a change in the storage volume of the aquifer occurs. Storage co-efficient is defined as the volume of water that an aquifer releases from or takes into storage per unit surface area per unit change in head.

In the confined aquifer, storage co-efficient is the result of compression of aquifer by the overburden and a small expansion of contained water, caused due to reduction of hydrostatic pressure during pumping. The value of storage co-efficient for confined aquifers ranges from 0.00001 to 0.001. The storage co-efficient for an unconfined aquifer corresponds to its specific yield and the nature ranges from 0.01 to 0.35.

8.2 Some commonly used terms:

Drawdown : It is the difference between the static water level and the pumped water level.

Specific capacity : Specific capacity of a well is its yield per unit of drawdown, usually expressed as gallons per minute per foot of drawdown.

Cone of depression : When a well is pumped the piezometric surface around the well is depressed due to loss of head caused by resistence of the soil during movement of water resulting in a shape of cone of the water table. This is called the cone of depression.

Radius of influence : It is the distance from a pumping well to the limit of cone of depression, i.e. where drawdown is negligible, is known as the radius of influence.

9. SUB-SURFACE INVESTIGATION OF GROUND WATER:

In order to obtain factual information on quality of aquifer (location, thickness, composition, permeability, yield etc.) and quality of water at different depths, locations, detailed sub-surface investigation has to be conducted. Evaluation of these factors is of immense importance for proper location, construction and development of wells and helps in programming a balanced ground water development and management.

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9.1 Exploratory Borings are conducted at different places for obtaining data on sub-surface formations. Some relevant procedure for such test wells are given below. A well log is prepared which records the geologic formations encountered, water quality at different depths etc. after completion of a test well.

9.2 <u>Collection of sand samples</u> :

i) Soil samples from the borehole from the beginning of 10 ft. drilling till final washing should be collected and unless the drilling fluid is too thick with mud mixture only a nominal washing of samples should be made, so that fines are not lost during washing.

ii) The wet samples should be dried and kept serially according to depth in a wooden compartment or in a place protected from rain and windblow.

iii) If within a 10 ft. sand section any clay is encountered, it should be noted in field log, giving the thickness and nature of clay layer.

iv) The dried samples should be filled in bags capable of holding about one pound of sand sample. The depth, field classification and name of P.S. written in a piece of paper should be inserted in the bag and sealed tightly. The depth should also be noted on the outside of body of the bag.

9.3 <u>Classification of soil sample in the field:</u>

i) Sand and gravels are granular material consisting of readily visible grains. In classifying sand as fine, medium, or coarse, judgement should be exercised as far as possible. Fine sand : .005" to 0.01", Medium sand : 0.01" to 0.02", Coarse sand : 0.02" to 0.04", very coarse sand 0.04" to 0.08", over 0.08" is the gravel. Soil comparator may be useful in classification.

ii) Silt is granular material consisting of grains barely visible to naked eye, it is not plastic when wet and does not form hard clumps when dry.

iii) Clay is composed of invisible individual particles, it is plastic when wet and forms strong, hard clumps when dry.

iv) If any gravel or stone layers are found, their average size shape, colour, thickness of such layer should be noted.

9.4 <u>Collection of water sample and field test</u>:

Collection of water sample should be done only when the water has become clear and is devoid of turbidity, clay or sand particles and after sufficient pumping to get representative sample from aquifer and field tests should be done on the spot.

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9.5 Sieve Analysis:

Sieve analysis of samples obtained from test or production wells reveals the characteristics of the water bearing strata. During sieve analysis the dried aquifer sand is passed through a standard set of sieves by continuous shaking. The retained sands in each sieve is weighed and a graph is plotted with the cumulative percentage of sand retained against the opening size of the particular sieve. After graph is plotted, the grain size distribution of a particular sand in graphical form is obtained which can be used in designing the screen size openings and many other purposes.

The effective size of a sample is defined as the particular size where 90 percent is coarser and 10 percent is finer than this size. The uniformity coefficient is calculated as the quotient of the 40 percent size divided by 90 percent size (effective size) of the sand.

9.6 Geophysical methods : Electric logging

Geophysical methods provide indirect evidence of sub-surface formations that indicates whether the formation may possibly be aquifer. Most common bore-hole geophysical operation is Electric logging. An E-log consists of a record of apparent resistivities of the formations and instantaneous potentials generated in the bore-hole. These two properties are related indirectly to the character of the sub-surface formations and quality of water contained in them. They can be measured only in mud-filled uncased bore-holes and serves to supplement the descriptive logging of the hole recorded during drilling.

10. GROUND WATER IN BANGLADESH

10.1 Occurence and aquifer quality

The whole of Bangladesh, as we have already discussed is underlain by alluvial deposits of varying characteristics. The strata or sand sections containing water occur at varying depths from 50 ft. to several hundred feet below. This is sometimes overlain by several semi-imperirous lenses at different depths. The upper confining layer consisting of clay, silt and mixture of sand, silt varies in depth from 25 feet to 150 feet. The aquifer generally consists of medium sand with coarser grained aquifer in the northern portions and finer grained aquifers occuring in the extreme southern areas. The sand is of fairly uniform quality, uniformity coefficient normally ranging between 1.5 to 2.5, which is generally encountered in alluvial soils. The total volume of water stored in this vast aquifer is enormous.

The aquifer receives good recharge in large areas with overlying semi-permeable soils and through slow down ward movement called "delayed drainage" in the areas with semi-permeable overlying strata. This is of great importance because of high annual rainfall-being an average of 90 inches per year - which contributes largely to aquifer recharge.

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Presence of good aquifer at relatively shallow depths, generally high static water level, good recharge capability, absence of hard rocks encountered during boring etc. are prime factors that have contributed to a good ground water resources which can be exploited for irrigation, drinking water supplies and other water requirements.

10.2 Ground Water quality:

Ground water contains various dissolved solids and gases. Most objectionable constituent that is noted in Bangladesh is presence of excessive iron in various areas. Manganese is also found in some areas in high concentration. Presence of manganese make black stains and presence of iron make brown or reddish stains. Excessive hardness is found primarily in western and south western parts of the country. Salinity in ground water is noticed only in the coastal belt. Other chemical constituents are generally found within the acceptable limits. Careful selection of aquifer in respect of depth and location should be made so that the objectionable chemicals are within acceptable range and otherwise treatment facilities may have to be provided to remove these wherever necessary. Ground water is usually found at a fairly uniform temperature throughout the year.

References:

1) Ground water hydrology by D.K. Todd
2) Water supply & pollution control by Clark & Viessman
3) Ground water and wells......Johnson Inc.
4) Bangla Academy science magazine.

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TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: RURAL AND URBAN SANITATION

MARCH 1975

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RURAL AND URBAN SANITATION

1. Introduction

Sanitation in the wider application of the term should include practically all aspects of personal and environmental hygiene. This being too extensive a field, the attempt in this article will be confined to sanitation as far as it relates to the problems of "community wastes disposal".

Bangladesh is possibly the eighth most populous country in the world with an estimated population of some 75 to 80 million as at present. Of this, about 94% live in some 64,000 and odd villages and the rest in about 80 municipal towns.

Water-borne diseases particularly dysentery, cholera, diarrhoeah and other parasitic ailments are almost endemic in this country. The incidence of these diseases is undoubtedly related to insanitary living conditions.

2. Situation in Bangladesh in relation to other countries in South East Asia Region

Although the conditions of rural and urban sanitation are generally unsatisfactory in almost the entire region of the South East Asia, in the context of the numerous fields of development calling for heavy investments and perhaps more pressing priorities, Bangladesh will have to make special effort in this field if they have to move forward with other countries. For an urban population of nearly 5 million spread over some 80 municipal towns including the three major cities of Dacca, Chittagong and Khulna, there is no system of sanitary disposal of human waste except in a very limited area in xx Dacca. Even in this area, it is estimated that about 16,000 houses are still using the traditional system of bucket latrines (conservancy system) which leave very much to be desired from considerations of health and hygiene. As regards rural areas, where of course, congestion is felt more among market centres and in crowded villages, no system of sanitary disposal of excreta exists anywhere. In respect of waste water from human habitations in as much as piped water supplies in households are still few, the problem has not reached a crisis yet. It would when a good portion of population are provided with adequate supply of water. The Table I gives a fair indication of the population coverage in respect of water supply and sewage disposal in some of the countries in the region as of 1970 as reported in WHO Statistics Report.

3. Global Targets

The targets laid down for 1980 and the achievements of these targets approximate cost for the countries of the region are given in Table II.

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4. Scope and Priorities

The scope of achieving the targets set under the UN Development Decade, is essentially dependent on several factors, namely, finance, materials, and manpower. In a developing young country like Bangladesh with its extremely difficult problems of food, and the inter-related fields of development in industries, communications, education, housing, etc. and the global energy crisis, the extent to which improvement of sanitation should be attempted is a difficult matter to be decided upon. The planners have generally laid down a firm policy in respect of improvement of rural water supply and sanitation, but the urban areas more or less to wait except of course Dacca and Chittagong. In the rural areas, Bangladesh is doing exceptionally well with the current and proposed programme of sinking several thousands of shallow and deep tubewells. The global target of 25% coverage of population by 1980 has already been surpassed. This is of course due to abundant ground water resources in Bangladesh, the simple expediency of sinking wells with practically no mechanical aids and above all the liberal UNICEF assistance. However, the use of tubewell waters thus provided by the people, in adequate quantities and for all their household purposes, is still a matter of concern. Attempts, of course, are being made to impart better education through various media including schools. The combined operations of the UNICEF, DPHE and WHO in this regard are bound to bring better results in course of time. In regard to rural sanitation, an attempt at popularising the use of water seal sanitary latrines, is initiated already but the progress is slow for obvious reasons.

While the rural situation is fairly gratifying, the position in respect of urban water supply and sanitation is far from satisfactory. In the first instance, in most of the urban towns, the water supply now available, is very much below the demand, it is intermittent and irregular, inadequate in pressure and due to heavy leakage and other allied reasons of doubtful quality. It was only by providing about 6,000 tubewells distributed among some 80 municipal towns, the scarcity of water in these areas was met with to some extent in the recent past.

Water-borne diseases are mostly caused by faecal contamination of water and logically therefore the safe disposal of human excreta is the most obvious solution. This naturally calls for a deliberate effort in dealing with this problem both in the urban and peripheral urban areas as also the crowded rural areas. It would not be wise to wait for everyone of the towns to have a pucca piped water supply system and all the houses provided with internal plumbing and then think of sewage disposal. It was possible in the developed countries because of the industrial resource potential they developed even before tackling the field of sanitation.

The writer is firmly of the view that without waiting for construction of pucca piped water supplies for every town, the crucial problem of safe disposal of human excreta in all the towns, and their peripherial

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areas, the crowded slums, etc. should be tackled as quickly as possible. This is more so because the conservancy system now obtaining in these towns becoming increasingly difficult to manage, they are by no means satisfactory either in respect of covering the whole area or rendering a satisfactory service to the households. Besides, the scanvengers who are made to do this hazardous work, are gradually reducing in number nor are they becoming economically manageable by any municipality. It is now found that some municipalities have strangely abolished the conservancy system without at the same time providing alternative means of collection and disposal of human wastes. This is a matter of public health importance and in a town where density of population is high, it becomes obligatory on the part of the municipality to provide suitable means of disposal of excreta, the extent to which the house owner can make his own arrangement by septic tank system, etc. is extremely limited.

It is, therefore, be a matter of extreme urgency to assess the extent of the problem in the various towns, divide them into different zones for being tackled independently with suitable systems of disposal for the area concerned. For example, in the residential area of a town, where houses are well-built and premises are also available, septic tank system should be enforced; in some areas aqua privies and in some others community latrines with independent allotment of rooms to families and in yet other areas, pit latrines with water seal slabs and even bore-hole latrines where feasible, can be encouraged. This does not call for heavy capital and in most cases can be done through a cooperative system of work as in urban housing. Where in a city a portion is fully built up and piped water supply also is available, an underground sewerage scheme with the sewage pumped away into some stabilisation pond or lagoon may be worthwhile. This can be taken as the first phase of a Master Plan for the city.

5. Current and Proposed Schemes

As at present in Bangladesh in the field of disposal of community wastes for the urban city of Dacca, a major scheme for underground sewerage is in the process of implementation with IDA credit. There is also a pre-investment study being carried out to examine the feasibility of converting some 16,000 dry (bucket) latrines in old Dacca city to hand flushed toilets to be connected to the existing sewers.

Other than this, there is nothing in the plan. By way of promotion of sanitary latrines with community participation, works are in progress more in the form of pilot projects to the extent of local acceptance to sanitary pit privies. A scheme for introducing this in some 620 villages and 700 and odd schools in the course of the current plan, has been sanctioned but is pending execution for the completion of the pilot studies.

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6. Constraints

Because of the substantial assistance being obtained from various international and bilateral agencies particularly from UNICEF, IDA, etc., financial constraints do not as such exist in respect of foreign exchange, although to meet the local costs there appears to be difficulties because of completing fields and priorities. Constraints, however, do exist in respect of construction materials, like, cement, iron, pumps, machinery, etc. which are to be imported. The quantities locally manufactured in respect of some of the items are far short of requirements.

In respect of manpower, there is no shortage numerically although in terms of expertise in management and technical skill in various fields training is largely called for.

7. Engineers' Role

For the young engineers of the department for whom training programmes are being organized by the department from time to time, the entire field of promotion of environmental health should be a challenge. They should take up these programmes with a sense of dedication, willingness and patriotism to put in their best effort in making every scheme a success and its benefits to maximum utilization by the people. In other words, the engineers must see whether the works assigned to them whether they may be water supply tubewells or latrine constructions, are built properly and whether the amenities provided are properly used by the people. They should assume the role of general health educators, train everyone under them as service-minded sevaks, educate the public, young or old as well as the school boys and girls in whom lie the future of the country. They should let the public feel that the DPHE is essentially meant for the improvement of public health and is not just a construction organization.

8. Conclusions

It may take several decades before the standard of sanitation as obtaining in the developed countries of the West, can be reached in Bangladesh or for that matter in any of the developing countries in our region. But that should not in any way be disappointing.

With the enormous potential of a large population, a fertile soil and abundant water, Bangladesh engineers can definitely help to build this nation to maturity and from there into full growth provided they work hard, intelligently, sincerely and untiringly.

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TABLE I : COMPARISON OF SERVICES - WATER SUPPLY AND SEWAGE DISPOSAL

Name of country	Urban Water Supply		Rural Water Supply		Urban Sewage Disposal		Rural Excreta Disposal	
	Population covered by house connec-tions	Percentage coverage to total popula-tion	Population with reason-able access to safe water	Percentage coverage to total population	Population connected to sewers (with or without treatment)	Percentage coverage to total population	Population with adequate arrange-ments	Percentage coverage to total population
Bangladesh	750	16	31,850	43	500	11	100	-
Burma	369	7	4,945	18	263	5	7,200	32
India	46,400	39	91,300	16	40,000	34	5,000	1
Indonesia	5,000	23	7,500	6	460	2	4,250	4
Nepal	13	2	323	3	40	8	5	-
Srilanka	920	36	1,810	14	364	14	4,000	39
Thailand	330	10	6,216	17	-	-	2,500	8

TABLE II : GLOBAL TARGETS FOR 1980 AND COSTS ESTIMATED FOR ACHIEVEMENTS

Name of country population in thousands	Urban Water Supply: Population to be connected to public W/S system in 1980	Urban Water Supply: Increase over 1970 population	Urban Water Supply: Cost of achievement of targets in US$ (million)	Urban Sewage Disposal: Population to be connected to public sewerage system in 1980	Urban Sewage Disposal: Increase over 1970 population	Urban Sewage Disposal: Cost of achievement of targets in US$ (million)	Rural Water Supply: Population to be served with reasonable access to safe water	Rural Water Supply: Increase over 1970 population	Rural Water Supply: Cost of achievement of targets in US$ (million)	Rural Excreta Disposal: Population to be covered with safe disposal of excreta	Rural Excreta Disposal: Increase over 1970 population	Rural Excreta Disposal: Cost of achievement of targets in US$ (million)
Bangladesh	4,694	3,944	35.5	3,129	2,629	42.1	24,093	-	-	24,093	23,993	48.0
Burma	4,639	4,270	64.1	3,093	2,830	45.3	6,937	3,942	23.7	6,937	-	-
India	1,06,016	59,616	894.2	70,677	50,677	490.8	1,37,461	1,12,460	899.7	1,37,460	1,32,460	264.9
Indonesia	20,002	15,002	300.0	13,334	12,874	206.0	32,863	32,863	131.5	32,863	28,613	143.1
Nepal	527	514	5.1	352	312	5.0	3,355	3,345	50.2	3,355	3,350	10.1
Srilanka	2,262	1,342	20.1	1,508	1,144	18.3	3,087	2,997	62.9	3,087	-	-
Thailand	5,338	2,497	62.4	3,559	3,559	56.9	10,417	7,417	74.2	10,417	7,917	95.0

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : WELL HYDRAULICS AND WELL DESIGN

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MARCH 1975

SECTION - I : WELL DYDRAULICS

1.1 Introduction:

Tubewell is a hydraulic structure and a clear understanding of the fundamentals of well-hydraulics is an essential prerequisite to proper design and successful operation of a tubewell. A detailed study on different aspects of the hydraulics of ground water and wells is beyond the scope of this paper. Attempts have been made only to familiarize the readers with the fundamental concepts and further studies are essential before any practical application of these concepts are attempted.

1.2 Darcy's Law and It's Application to Well Hydraulics:

Darcy's Law states that flowrate through porous media is directly proportional to the head loss and inversely proportional to the length of the flow path.

$$V = P \frac{(h_1 - h_2)}{l} \quad \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad (1\text{-}1)$$

where V = velocity

P = co-efficient of permeability

l = length of flow path in which head loss occurs

(h_1-h_2) = difference in hydraulic head

The equation (1-1) can be rewritten as :

$$V = P\,I \quad \ldots \quad \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad (1\text{-}2)$$

where I = hydraulic gradient

or

$$Q = PIA \quad \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad (1\text{-}3)$$

where A is the cross sectional area

Q = Discharge

or

$$Q = TIW$$

where T = co-efficient of transmissibility

W = width of vertical section

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1.3 Equilibrium Well Formulas:

The basic equilibrium equation for an unconfined or water-table aquifer may be defined as :

$$Q = 2 \, xy \, \pi \, P \frac{dy}{dx}$$

where $2 \pi xy$ = A cylindrical area at any section

$P \frac{dy}{dx}$ = flow velocity

Integrating over the limits H, h and R, r as in figure (1-1)

$$Q = \frac{\pi P (H^2 - h^2)}{\log_e (R/r)} \quad \ldots \quad \ldots \quad (1\text{-}4)$$

which can be rewritten in terms of convenient units.

$$Q = \frac{P (H^2 - h^2)}{1055 \log (R/r)} \quad \ldots \quad \ldots \quad (1\text{-}5)$$

where Q = well discharge in gpm

P = permeability in gpd per sq.ft.

H = saturated thickness of the aquifer, before pumping, in ft.

h = depth of water in well while pumping, in ft.

R = radius of the cone of depression, in ft.

r = radius of the well, in ft.

For confined or artesian aquifer discharge through a well (Fig. 1-2) can be defined as

$$Q = \frac{Pm (H-h)}{528 \log R/r} \quad \ldots \quad \ldots \quad (1\text{-}6)$$

where m = thickness of the aquifer, in ft.

H = static head at the bottom of the aquifer, in ft.

Other notations are same as previous equation.

1.4 Non-Equilibrium Well Formula:

Theis developed non-equilibrium formula in 1935. The derivation of Theis non-equilibrium formula was a major advancement in the field of groundwater hydraulics. By the use of these formulas, the drawdown can be predicted at any time after pumping begins. The transmissibility and the average permeability can be determined from the early stages of pumping test rather having to wait until water level in the observation wells have virtually stabilized or reached equilibrium.

In the simplest form, Theis non-equilibrium formula is :

$$s = \frac{114.6\ Q}{T}\ W(u) \quad \ldots \quad \ldots (1\text{-}7)$$

where

s = drawdown, in ft. at any point in the vicinity of a well discharging at a constant rate

Q = Pumping rate, in gpm

T = Co-efficient of transmissibility in gpd per ft.

W(u)= The well function of 'u' and is short for the exponential integral written as

$$\int_{1.87\ r^2S/T}^{\infty} \frac{e^{-u}}{u}\, du = W(u) = -0.5772 - \log_e u + u - \frac{U^2}{2x2!} + \frac{U^3}{3x3!} \quad \ldots\ldots \quad (1\text{-}8)$$

In this expression

$$u = \frac{1.87\ r^2 S}{Tt} \quad \ldots\ldots \quad (1\text{-}9)$$

where r = distance in ft. from centre of the pumped well to point where drawdown is measured.

S = Co-efficient of storage (dimensionless)

T = Co-efficient of transmissibility, in gpd per ft.

t = Time since pumping started, in days.

A direct calculation from equation (1-7) and (1-9) is not possible. The equations can be solved by comparing a log-log plot of 'u' vs W(u) known as a "type curve", with a log-log plot of observed data r^2/t vs s. In plotting the type curve, W(u) is the ordinate and 'u' is the abcissa. The two curves are superimposed and moved about until some of their segments coincide. In doing this, the axes must be maintained parallel. A coincident point is then selected on the matched curves and both plots are marked. The type curve then yields values of 'u' and W(u) for the selected point. Corresponding values of s and r^2/t are determined from the plot of the observed data. Inserting these values in equations (1-7) and (1-9) and rearranging, values for transmissibility T and storage coefficient S may be found.

1.5 Modified Well Formula:

Jacob found out that 'r' is small and t is large, values of u are generally small. When 'u' is less than 0.05, the Theis equation can be modified as

$$s = \frac{264\ Q}{T} \quad \frac{(\log 0.3\ T_t)}{r^2 S} \quad \ldots\ldots \qquad (1\text{-}10)$$

where the symbols represent the quantities as in previous equations.

Applying the modifications as suggested by Jacob, the time-drawdown graph is plotted on semi-logarithmic paper. Time, 't' is plotted horizontally on a logarithmic scale; drawdown s is plotted on the arithmetic scale. The straightline drawn through the plotted points fits all of them, except for the measurements made during the first 10 minutes, value of 'u' is larger than 0.05, so modified formula is not applicable within that region of the test.

The co-efficient of transmissibility is calculated from the pumping rate and from the slope of the time - drawdown graphs by using the following relationship developed from formula (1-10)

$$T = \frac{264\ Q}{\Delta s} \quad \ldots\ldots \qquad (1\text{-}11)$$

where T = coefficient of transmissibility in gpd per ft.

Q = pumping rate in gpm

Δ s = slope of the time - drawdown curve expressed as the change in drawdown between any two values of time on the log scale whose ratio is 10.

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The coefficient of storage is also readily calculated from the time - drawdown graph by using the zero-drawdown intercept of the straightline as one of the terms of the equation. The following formula derived from formula (1-10)

$$S = \frac{0.3 \; T_t}{r^2} \quad \ldots \quad \ldots \quad (1\text{-}12)$$

where

S = storage coefficient

T = coefficient of transmissiblity

t = intercept of the straightline at zero drawdown, in days

r = distance, in ft, from pumped well to observation well where drawdown measurements were made.

1.6 Pumping Tests

To determine the characteristics of the aquifer and the performance of the tubewell; it is necessary to conduct pumping tests. By pumping test, the following aspects can be determined:

i) Transmissibility and storage co-efficient of the aquifer.

ii) Specific capacity of the well.

iii) Safe yield from the well.

iv) Long term pumping effect on the aquifer.

v) Probable interference on other existing or proposed wells at different distances.

vi) The degree of well development.

Pumping tests can be done in any of the following two ways:

i) Constant Rate Pumping Test:

In this the tubewell is pumped at a constant rate of discharge for a long time ranging from 12 hours to 14 days or even more. During the pumping water level, in the pumping well as well as in observation wells are measured at definite intervals.

The observed data are analysed by using Theis non-equilibrium formula and the modified formula and the values T.S and other characteristics of the aquifer can be determined.

ii)Multiple Step Drawdown Test:

This is a short term test and the well is pumped at different rates of discharge. Initially, the well is pumped at a rate of about 75% of the design pumping rate for a period of 90 to 120 minutes, then the discharge rate is suddenly increased to 100% of the design pumping rate and then the well is pumped again for another 90 to 120 minutes. The discharge rate is again increased to 125% of the design rate and pumping is continued for another 90 to 120 minutes. During this entire period water level is measured at definite intervals.

The multiple step-draw down test is usually conducted to determine how efficiently the well has been developed. The following relationship is used.

$$s = BQ + CQ^2 \qquad \text{............ (1-13)}$$

or

$$\frac{s}{Q} = B + CQ \qquad \text{............ (1-14)}$$

where s = drawdown

B = formation loss constant

C = well loss constant

The constants B & C for a particular well signify the hydraulic performance of the well.

For value of C less than 5 = well developed efficiently

C between 5 & 10 = mild deterioration as some screen slots are plugged.

C more than 10 = severe clogging

To determine B & C from a multiple step drawdown test, values of s for each step is determined by plotting time drawdown curve on a semi log paper. s/Q values can then the calculated. s/Q values are then plotted against Q values. There should be a straight line passing through these points. Then

C = slope of the straight line

B = intercept at X-Axis

since the equation (1-14) represents that of a straight line.

Besides determining the extent of development, the efficiency of the well and the approximate values of transmissibility can also be determined from the data of a step drawdown list.

Studies in respect of conducting pumping tests for municipal wells were carried out by Camp, Dresser & McKee consultants to the Directorate of Public Health Engineering. Step by step instructions for pumping tests including specifications for test and observation wells were prepared by them. These appear in the "DPHE Engineers Note Book".

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SECTION 2 : DESIGN OF TUBEWELL

2.1 General

Design of a tubewell involves the following:

i) Selection of the diameter of the well
ii) Selection of length of strainer
iii) Selection of slot size of strainer
iv) Selection of materials of pipes and strainers
v) Selection of diameter of strainer

In case of handpump tubewells, individual design of each tubewell is not practicable and since the yield of tubewells are very small (4-8 gpm) a general design is followed for all the wells in a general area.

However, for municipal wells where much larger yields are anticipated, each well should be designed properly on the basis of the expected yield and the aquifer conditions.

2.2. Well Diameter

Cost of the well depends to a great extent on the diameter of the well casing (pump housing and the blind pipe) and the well screens. Special attention must be given to the selection of these components. The upper well casing or the pump housing should be large enough to accomodate the pump. Usually the casing size is two nominal size larger than the pump bowl size.

The following table will give the recommended casing sizes for different well yield or pumping rate. To prepare the table, the bowl size of the most efficient vertical turbine pump that would give the design quantity of water was first determines. The optimum casing size was then selected as being two nominal size larger than the best bowl size.

Anticipated Well Yield in gpm.	Nominal size of Pump bowls in inches	Optimum size of Well Casing in inches	Smallest size of well casing in inches
less than 100	4	6 ID	5 ID
100 to 175	5	8 ID	6 ID
150 - 400	6	10 ID	8 ID
350 - 650	8	12 ID	10 ID
600 - 900	10	14 OD	12 ID
850 - 1300	12	16 OD	14 OD
1200- 1800	14	20 OD	16 OD
1600- 300●	16	24 OD	20 OD

The diameter of the lower well casing or the blind pipe should be such that friction losses are low. In our country, it is customery to use same sizes for screen as well as lower well casing.

2.3 Length of Strainer

The most suitable length for the strainer is determined on the basis of the thickness of the aquifer, available drawdown and stratification of the aquifer.

In a confined aquifer, about 70 to 80 percent of the thickness of the water bearing sand should be screened - assuming that the pumping water level will not go below the top of the aquifer.

In an unconfined aquifer, the bottom one-third of the aquifer should screened. In some cases, however, bottom one-half of the aquifer may also be screened to get higher yield.

2.4 Slot Size of Strainer

Slot size of strainers are selected on the basis of size of the surrounding san.. A sand analysis curve is plotted for the sample to be screened and then 40 percent size of sand is selected as the size of slot of the strainers. Thus slot opening is selected in such a way as to pass 60 percent of the sand through the strainer during development. Sometimes to be on safe side and to avoid pumping of sand, 50 percent or higher size is used instead of 40 percent.

2.5 Diameter of the Strainer

Strainer diameter is selected in such a way as to provide enough open area in the strainer so that the entrance velocity through the strainer does not exceed the allowable limit. Screen length depends on the thickness of the aquifer and the slot openings depend on the size on the sand. So, strainer diameter is the only factor that can be varied. Usually, the strainer diameter is selected in such way so that the entrance velocity does not exceed 0.1 ft/sec. However, this figure is considered to be too conservative by some ground water engineers.

2.6 Gravel Shrouded Wells

In some wells, the natural formation around the screen are removed by drilling a large diameter hole and this space is refilled with gravel. These wells are called gravel packed or gravel shrouded wells. In a naturally developed wells, 60% of the formation are pumped out through the strainers and thus creating more permeable formation around the strainer. In a gravel shrouded wells a more permeable formation is created artificially by placing gravels around the strainer.

.....10/

Gravel packed wells are constructed where formation consist of fine uniform sand with low permeability or the formations are extremely laminated.

In a gravel shrouded wells, thickness of the gravel shrouding should vary between 4 to 8 inches. Thus, for a 8-inch well, diameter of the hole should be around 20".

The size of the gravel to be used in a gravel shrouded well depends on the size of the natural formation around the well. The following procedure may be used in selecting the size of the gravel.

i) Sieve analysis curves for all strata comprising the aquifer are prepared end that the finest sand stratum is considered for determining the size of the gravel.

ii) 70% size of this sand is multiplied by a factor of 4 to 6 and that will be 70% size of the gravel to be used. This will also serve as an initial point for a proposed curve for the grading of gravel.

iii) To determine the grading of the gravel a curve is drawn through the initial point in such a way so that uniformity co-efficient is 2.5 or less.

iv) Specifications for the gravel are then prepared on the basis of this curve using 4 or 5 sieve sizes. The percentage to retained by each sieve may vary within the range of ± 8 percent from the values shown in the curve.

2.7 Conclusions

This procedure of well design as described above has very little bearing in case of hand pump tubewells except for the fundamental concepts. It is impractical to have individual design for different components of the tubewell in case of handpump tubewells. On the other hand standard sizes of strainers, slot openings, blank pipes are used over an extensive area for obvious reasons.

MA/PQ

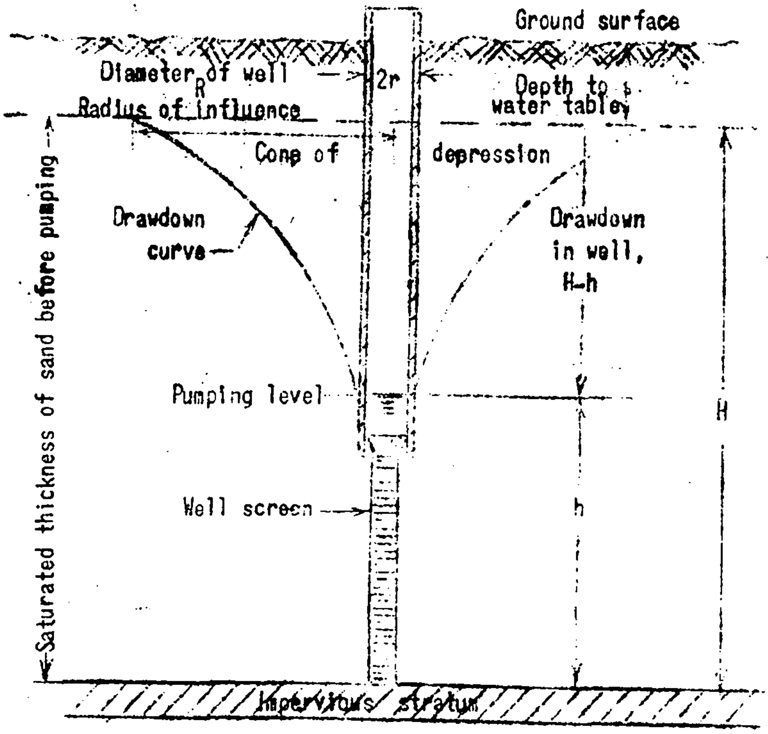

Figure 1-1. Diagram of water-table well showing the significance of the various terms used in the equilibrium formula.

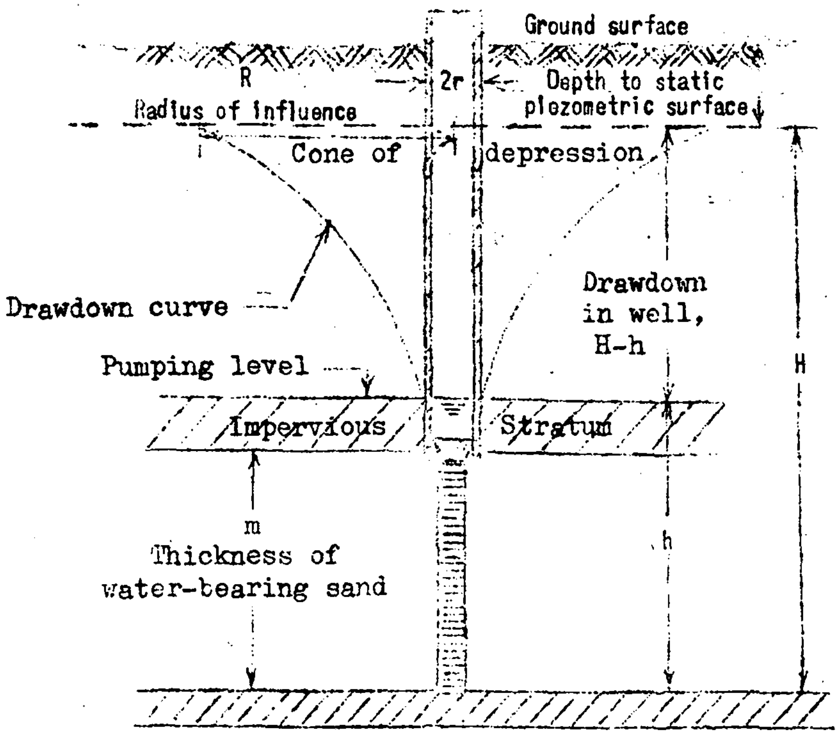

Figure 1-2. Diagram of well in artesian aquifer showing the meaning of various terms used in the equilibrium formula.

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: LABORATORY PRACTICES

IN

WATER QUALITY CONTROL

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March 1975

LABORATORY PRACTICES IN WATER QUALITY CONTROL

1. INTRODUCTION:

Water in the chemical composition, H_2O is pure. Distilled or clean rain water is in this form. All other waters either ground waters or surface waters are contaminated with one or more contaminants and may technically be called "polluted" or impure water. Impurities in water can be divided into 3 groups; physical, chemical and biological.

<u>Physical</u> impurities are radioactive fall-outs.

<u>Chemical</u> impurities are all minerals.

<u>Biological</u> impurities both macro and micro are contaminants of all organic wastes and micro-biological organisms.

Impure water and unsafe water are not the same thing. The impurities or extent of impurities in water determine the extent to which such waters are harmful to men and animals; these waters are called unsafe water for drinking purposes. Examples: water containing pathogenic bacteria (disease causing bacteria) are unsafe. Water containing radioactive fallouts are unsafe. Waters containing concentrations of certain minerals or biological waste though not always unsafe could be offensive to the senses of sight, smell and taste.

It is not possible to determine the extent of impurities in water by visual observation or oral tests. It is only laboratory practices that can determine water quality and standardize them for different uses.

2. WATER POLLUTION CONTROL:

This is a broadbase control of both surface and ground water, nationally or sometimes internationally against pollution. Rivers and lakes are the natural result of the run-off of surface waters. As the waters flow over the ground surface, they pick up organic and inorganic materials which stimulate biological growth. Stream pollution is aggravated more by urbanization and industrialisation.

Bangladesh has constituted a Water Pollution Control Board under the Water Pollution Control Ordinance 1970 defining "Water Pollution" which reads as follows: "Pollution means such contamination, or other alteration of the physical, chemical or biological properties of any waters, including change in temperature, taste, colour, turbidity or odor of the waters or such discharge of any liquid, gaseous, solid, radioactive, or other substances into any waters as will or likely to create a nuisance or render such water harmful, detrimental or injurious to public health, safety or welfare or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life."

One of the functions of the Board is to standardise water quality of different water courses for beneficial uses. The laboratory tests for these are the determination of B.O.D. and C.O.D. and sometimes Bio-assay.

2.1 B.O.D. (Biochemical Oxygen Demand)

One of the most important tests for the determination of the pollution strength of organic wastes, is the 5-day BOD test. Essentially, it is the measurement of the oxygen utilized by micro-organisms over a period of 5 days at a constant temperature of 20°c. This is done artifically by collecting a fixed amount of the sample of polluted water in a container and aerating it under ideal conditions. BOD test is also done for domestic sewage treatment plants.

2.2 C.O.D. (Chemical Oxygen Demand)

C.O.D. is based on the fact that all organic compounds, with a few exceptions, can be oxidized by the action of any strong oxidizing agent. This is in effect an oxidation and reduction process.

C.O.D. of a waste water is determined in the laboratory by filtration with Potassium Di-chromate solution and an indicator named Ferroud by colour change.

Heavy metals like Cyanide, Arsenic, Chromium, Cadmium etc. are also identified in the laboratory tests for water pollution control.

2.3 Bio-Assay Test

This is a sophisticated test which determines the degree of water pollution from industrial toxic chemicals and from pesticides and insecticide.

3. WATER QUALITY CRITERIA:

Different countries have established water quality criteria of their own for commercial, drinking, irrigation industrial and other uses; but all of them are more or less similar.

4. DRINKING WATER QUALITY:

The drinking water quality as standardized by WHO during 1963 is universally accepted. They are:

Substance	Max.Acceptable Concentration	Max.Allowable Concentration
Total solids	500 mg/1	1500 mg/1
Colour	5 units*	50 units*
Turbidity	5 units**	25 units**
Taste	Unobjectionable	———
Odor	Unobjectionable	———
Iron (Fe)	0.3 mg/1	1.0 mg/1
Manganese (Mn)	0.1 mg/1	0.5 mg/1
Copper (Cu)	1.0 mg/1	1.5 mg/1
Zinc (Zn)	5.0 mg/1	15 mg/1
Calcium (Cal)	75 mg/1	200 mg/1
Mangnesium (Mg)	50 mg/1	150 mg/1
Sulfate (SO)	200 mg/1	400 mg/1
Chloride (Cl)	200 mg/1	600 mg/1
pH range	7.0 - 8.5	Less than 6.5 or greater than 9.2
Magnesium + sodium Sulfate	500 mg/1	1000 mg/1
Phenolic substances (as phenol)	0.001 mg/1	0.002 mg/1
Carbon chloroform extract (CCE: organic pollutants)	0.2 mg/1	1.5 mg/1 ***
Alkyl Benzyl Sulfonates (ABS: Surfactants)	0.5 mg/1	1.0 mg/1

* Platinum -cobalt scale

** Turbidity units

*** Concentrations greater than 0.2 mg/1 indicate the necessity for further analysis to determine the causative agent.

5. NATURE AND SIGNIFICANCE OF WATER ANALYSIS:

To determine properties of water (treated or untreated, surface or groundwater) it needs a laboratory for proper analysis. More than 40 or 50 properties are subject to determination, but here, a few of the properties which have great significance to drinking water supply have alone been discussed. Results of water analysis are reported in terms of some units of measurements. Common unit of dissolved minerals is in parts per million (ppm) by weight. One ppm means one part, by weight of the dissolved mineral substance contained in one million parts, by weight, of the solution.

Many laboratories, report analysis in units of milligram per liter (mg per l). This is the same as ppm, as assumed one liter of water weighs one kilogram (which is one million milligrams).

The dissolved minerals remain in the water in the form of ions. So, concentration means concentration of ions of individual mineral. So, chloride content in water means chloride ions——— not sodium chloride (common salt). It may be from sodium chloride, potassum chloride or magnesium chloride.

5.1 pH

A water molecule, H_2O, has a slight tendency to break down into ions in the same way as some dissolved minerals are ionized. When the water molecule ionizes, it divides into a positive hydrogen ion (H^+) and a negative ion (OH^-) called the hydroxyl ion. Ion concentration of water is expressed by its pH value. The range of pH is from 1 to 14. A pH value of 7 indicates a neutral water, neither acidic nor alkaline. A pH less than 7 indicates an acidic condition and a pH greater than 7 corresponds to an alkaline condition. Concentration of H^+ ion indicates acidity an concentration OH^- ion indicates alkalinity.

pH 7 is the condition of distilled water. If the pH is changed from 7 to 6, the number of H^+ ion concentration has increased 10 times. If pH is changed from 7 to 8, the number of H^+ ion concentration is decreased to $\frac{1}{10}$ than it was in the distilled water: on the other hand OH^- ion has increased 10 times.

Acidic water is corrosive to metal and harmful for consumption.

The pH value of most groundwater is controlled by the dissolved carbon-dioxide gas and dissolved carbonate and bicarbonate, in the mineral salts. The carbon dioxide bicarbonate system becomes unstable when the water is pumped from a well due to release of pressure. So, a sample of water taken from a well is not a true sample representation of the aquifer water unless it is brought to the laboratory in a tightly sealed bottle. This situation makes field determination of pH somewhat more desirable than laboratory tests.

5.2 Specific Electrical Conductance

The electrical conductance is the ability of a substance to conduct an electric current. It is just opposite to the electrical resistance.

Chemically pure water (distilled water) is a poor conductor of electricity. But, a small amount of dissolved mineral renders the water a good conductor. This is due to the ionization of minerals into positive and negative charges. The specific conductance varies directly, therefore, with the dissolved minerals in the water.

The unit of measurement of conductance is the inverse of ohms, which is the unit for expressing resistance, and is written as 'mhos'.

The specific conductance multiplied by a factor between 0.55 to 0.75 will give a good estimate of dissolved solids (in ppm), This is the quickest method for determining dissolved solids of a water and particularly of tubewell water at site.

Water containing dissolved solids below 500 ppm is quite suitable for domestic use and for many industrial uses. Water with more than 1000 ppm of dissolved solids may, give disagreeable taste. High concentration of dissolved minerals is potentially corrosive to steel and iron.

5.3 Iron (Fe)

Practically all natural waters contain some iron. Concentrations of 1 to 5 ppm in groundwater are common.

Concentration of iron in a water sample is measured colourimetrically by adding a chemical named phenanthroline or tripyridine to the sample of water for an average red complex.

Iron in water stains plumbing fixtures and cloths, incrustates well screen and plugs pipes. Rural people of Bangladesh are unfortunately made to drink hand tubewell water containing iron upto even 5 or 6 ppm without complaint. When there is no other source of a better water, what else they can do. At least this is safe water.

Two kinds of iron ions occur commonly — ferrous (Fe ++) ions have charges equal to 2 electrons and ferric (F +++) ions have charges 3 electrons. Iron in the ferrous state is unstable and is oxidized into ferric iron in presence of air and comes out of solution. The chemical compounds formed by aeration are iron hydroxide and iron oxide. When the iron content of the water is excessive aeration and filtration are done to reduce the content to the desired level.

During sampling water from a well, the bottle should be sealed airtight to avoid aeration. It is best for that reason to test iron in the field.

5.4 Chloride (Cl)

Chloride content in sea water is about 19,000 ppm. Water containing more than 350 ppm is objectionable for most irrigation or industrial uses. Waters containing as much as 500 ppm of chloride frequently have a disagreeable test. It depends on the tolerance limit of the users to drink water containing chlorides up to 600 ppm or more.

Chloride content in water can be tested in the laboratory as well as in the field by treating a sample with silver nitrate solution and potassium chromate.

5.5 Manganese (Mn)

Manganese resembles iron in its chemical behaviour and in its occurrence in natural water. It occurs as soluble manganese bicarbonate which changes to insoluble manganese hydroxide when it reacts with oxygen of the air. In higher concentration it stains the laundry and plumbing fixtures. The stains caused by manganese are more annoying than due to iron stains.

There are different procedures for determination of manganese in the water depending on its source and other minerals present. Basically it involves oxidation of manganese to permanganate and measure the color concentration photometrically.

5.6 Fluoride

Identification of fluoride is very important in drinking water supply. Though optimum concentration in drinking water is set at 1 ppm; the requirement varies for different age groups and different air temperature of different countries. If the water contains too much fluoride there is chance of occurrence dental defect known as "mottled enamel", particularly among children during the period when their permanent teeth are yet to be found. The optimum concentration for children of that age group is between 0.9 to 1.0 ppm. If the concentration is low there is chance of "dental caries" for adults. For adults, concentration of fluoride may be between 1 to 4 ppm. For warmer climate like ours, the limit of fluoride content should be between 0.8 to 1.4 ppm.

Water is conditioned in many water supply systems of developed countries.
Fluoride content in water is determined by color photometry.

5.7 Jar Test

Jar test is a part and parcel of any surface water treatment plant to determine the optimum dosages of coagulants for flocculation of suspended materials in the water. In Bangladesh where stream water is treated in the water works, a marked different dosages of coagulants are required between monsoon and dry season. So, without jar test use of coagulant for coagulation and flocculation of surface water would be either uneconomic or ineffective. Moreover, too much use of alum as coagulant, the water may turn acidic to an objectionable limit.

6. BACTERIOLOGICAL TESTS:

Bacteriological test through a routine test one is common with all water works. This is done in the laboratory to ascertain the presence of pathogenic bacteria in the drinking water. The habits of most pathogenic bacteria is the human intestines. There is another group of non-pathogenic bacteria called coliform bacteria which inhabit in billions in human intestinal tracts. Pathogenic bacteria cannot be detected by any ordinary test. But coliform bacteria can be detected by general laboratory test. Hence presence of coliform bacteria in a water sample is an indicator of fecal pollution of water which in turn indicates probable presence of pathogenic bacteria.

There are two procedures for bacteriological tests:

(i) Multiple tube fermentation test - (a) presumptive, and
(b) confirmed.

(ii) Membrane filter technique

In water works practices, bacteriological test is a routine affair. Water samples from different points, - from intake upto the consumers' ends should be tested in the laboratory, daily. The basis for number of samples to be tested daily may be stated as shown below:

Municipal Water Supplies Recommended Analysis Schedule

Sl. No.	Name of Main Town	District	Population 1972 Estimated	No.of sample required per month	Frequency (Interval)
1.	Dacca	Dacca	14,00,000	150	5 Daily
2.	Chittagong	Chittagong	8,20,000	82	3 "
3.	Narayanganj	Dacca	2,84,000	28	1 "
4.	Khulna	Khulna	4,02,000	40	2 "
5.	Barisal	Barisal	97,000	20	1 "
6.	Saidpur	Rangpur	79,000	16	Alternate days.
7.	Rajshahi	Rajshahi	96,000	20	1 Daily
8.	Comilla	Comilla	77,000	16	Alternate days.
9.	Mymensingh	Mymensingh	76,000	16	"
10.	Serajganj	Pabna	63,000	13	"
11.	Jessore	Jessore	66,000	14	"
12.	Brahmanbaria	Comilla	60,000	12	"
13.	Pabna	Pabna	58,000	12	"

Sl. No.	Name of Main Town	District	Population 1972 Estimated	No. of Samples required per month	Frequency (Interval)
14.	Rangpur	Rangpur	64,000	13	Alternate days.
15.	Jamalpur	Mymensingh	61,000	12	"
16.	Sylhet	Sylhet	52,000	11	"
17.	Dinajpur	Dinajpur	50,000	10	Every fourth
18.	Chandpur	Comilla	46,000	10	"
19.	Bogra	Bogra	68,000	14	Alternate days
20.	Faridpur	Faridpur	38,000	8	Every fourth day
21.	Kushtia	Kushtia	35,000	7	"
22.	Kishorganj	Mymensingh	33,000	7	"
23.	Tangail	Tangail	34,000	7	"
24.	Rajbari	Faridpur	22,000	5	"
25.	Natore	Rajshahi	19,000	5	Once a week
26.	Patuakhali	Patuakhali	17,000	4	"
27.	Habiganj	Sylhet	17,000	4	"
28.	Munshiganj	Dacca	13,000	3	"
29.	Cox's Bazar	Chittagong	10,000	2	"
			41,57,000	561	

7. **DISINFECTION:**

Drinking water should be absolutely free from pathogenic bacteria. During storage and transmission through pipe lines water may acquire and carry pathogenic bacteria. Therefore it should be ensured that the water is disinfected upto the consumers' ends. Disinfection of water means killing all the potentially dangerous organisms that may be present.

The most effective disinfecting agent for drinking water is the chlorine in gaseous or liquid form. Other chemicals that may be used for disinfection are ozone, iodine and potassium permanganate.

Chlorine demand, residual chlorine, combined available chlorine and breakpoint chlorine; these are the four very important points to be considered while dealing with chlorine for disinfecting drinking water.

Chlorine in pure water forms hypochlorous acid and hypochloric acid. It is the hypochlorous acid that causes disinfection.

If the water contains organic matter and dissolved minerals like iron, manganese, hydrogen sulphide and ammonia, the chlorine and hypochlorous acid react with some of these and form soluble and insoluble compounds.

Thus ammonia forms chloramines which though has disinfecting properties, but effectiveness of the available chlorine is reduced considerably and so, dosage of chlorine is required to be increased considerably.

The chlorine that has reached other dissolved minerals has also lost its disinfecting power. This amount of chlorine thus lost is called chlorine demand of the water. Total dosage of chlorine must be sufficient to satisfy this chlorine demand, with enough excess quantity left over for disinfection.

Residual chlorine is the amount of chlorine left behind after the chlorine demand having been met.

Residual chlorine that is available for disinfection in the form of chloramine is called combined available chlorine. As the dosage of chlorine is increased the residual chlorine increases up to a certain level and then decreases during oxidization of all the ammonia. This point is called break point.

With the addition of more chlorine and when no more chloramine is formed, the chlorine residual is then in the form of hypochlorous acid. The chlorine available in this form is called free available chlorine.

About 30 minutes time is required for added chlorine in the reservoir before water is let out into the distribution system. Enough chlorine must be added to the water to ensure a chlorine residual throughout the distribution system. The residual chlorine must be at least 0.1 to 0.4 ppm after 30 minutes contact period.

8. HARD WATER SOFTENING:

Hardness of water is measured by the amount of soap needed to produce lather. Hardness more than 200 ppm needs softening for household use.

The cause of about all hardness of water is the presence of dissolved calcium and magnesium salts.

In the laboratory process hardness is determined either by calculating the equivalent carbonate or bicarbonate and also by an organic acid (EDTA).

Total hardness of water may be divided into two groups:
Carbonate hardness and non-carbonate hardness.

Carbonate hardness is temporary hardness and can be removed by simply boiling to precipitate calcium and magnesium carbonates.

Non-carbonate hardness are the compounds of calcium and magnesium with sulphate, chloride and nitrate. Non-carbonate hardness cannot be removed by straight boiling.

In water works practices, hard water is softened by removing calcium and magnesium in the following two methods:

Lime-soda-ash treatment and zeolite treatment

Lime-soda-ash (sodium carbonate) applied to hard water reacts with calcium and magnesium to form insoluble calcium carbonate and magnesium hydroxide. They are removed by sedimentation and filtration.

When hard water is passed through a bed of Zeolites (granular materials) which has sodium ions attached, the calcium and magnesium are exchanged for the sodium, making the water soft containing sodium bicarbonates in exchange of calcium and magnesium. When all the sodium is thus exchanged, the Zeolite looses its exchange capacity. The zeolite is then regenerated by passing strong solution of sodium chloride (common salt) through the bed of Zeolite: In this process Zeolite receives sodium ions by giving up calcium and magnesium. Calcium and magnesium are removed by flushing out salt solution when Zeolite is ready for reuse.

This method is called ion exchange method.

9. DPHE LABORATORY:

DPHE has got two regional P.H.E. Laboratories one at Dacca and the other at Chittagong. These laboratories are fully equipped to make all kinds of tests of water and waste water. The major urban water supply system in Bangladesh is from groundwater and the entire rural water supply system is also from hand tubewells. The major problem with ground water in Bangladesh is iron and chloride. So, without having these laboratories it would not have been possible to ascertain water quality and sink economical and useful wells. The Bangladesh Water Development Board (BWDB), the Agricultural Development Corporation (ADC) and the Dacca and Chittagong Water Supply and Sewerage Authority (WASA) are also utilizing the services of these two laboratories.

Each laboratory is headed by one senior chemist assisted by some junior chemists, laboratory assistants and sample collectors.

DPHE is proposing to establish two more regional laboratories - one at Khulna and one at Rajshahi.

When these 4 laboratories are finally fully equipped with men and materials they would be in a position to help develop a monitoring system of all the growing water supply facilities both urban and rural. But, for systematic bacteriological tests each urban piped water supply facility would need a small laboratory of its own.

10. CONCLUSIONS:

Laboratory practice is an indespensible part of any water works or sewerage practice. Every water works should have one laboratory fully equipped for routine monitoring of drinking water supply. Laboratory practice saves chemicals for treating water. In water and waste water treatment, a laboratory should work like a "light in the darkness."

In planning a water supply or sewerage system, a miniature laboratory should always be included in it; otherwise planning of such systems remains incomplete.

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: WORK RULES, OFFICE RULES, FINANCE RULES, RESPONSIBILITIES OF ASSISTANT ENGINEERS

March, 1975

M. H. Khan
Superintending Engineer, DPHE
Khulna Circle

1. ASSISTANT ENGINEER, DPHE

(a) His position

(b) Rights and obligations

(c) Warrant of precedence

(a) The Assistant Engineers of DPHE posted in the Sub-Divisions of administrative districts of Bangladesh plays a vital role unique of its nature in the implementation of development programmes of the Government executed through the DPHE under the Ministry of L.G., R.D. and Cooperatives (L.G. Division).

(b) One Division of DPHE comprises of one, or two districts and is under the direct control of an Executive Engineer. The Assistant Engineers in Sub-Divisions work under the Division. They help the Executive Engineers in execution of works and they supervise the works of departmental contractors with the help of the two Sub-Assistant Engineers under them and four mechanics in each Thana. The mechanics not only supervise the rural hand tubewell works of contractors but also they repair and maintain the DPHE tubewells within their jurisdictions. The Assistant Engineer of DPHE is the drawing and disbursing officer of employees under him and he authenticate the bills of contractors for any nature of works executed under DPHE for payment by the Executive Engineer. He is the key man and on him depends the success of any work of the Directorate.

(c) The Assistant Engineer is the fourth man in the warrant of precedence in the DPHE after the Chief Engineer.

2. WORK RULES

The following are the works rules worth mentioning:

(a) Approval of scheme - Transmission to the Executive Authority.

(b) How to start the work - Budget - Revised budget - yearly allocation - working estimates - preparation of specifications, approved by competent authority.

(c) Calling for tenders - acceptance of tenders, issue of work orders, contract documents for works and supplies.

(d) Expenditures chargeable to works for purchases of various articles.

(e) Warnings to the contractors, cancellation of tenders.

(f) Work charge, contingent staff, etc.

(g) Getting department works - works on deposit accounts.

.../

The Assistant Engineer today is the future Chief Engineer of DPHE. He must, therefore, get himself conversant with the rules and regulations governing the public works very intimately from now.

(a) The Planning Cell of the Government of Bangladesh approves a scheme and submits it to the Cabinet of Ministers (NEC) who finally give approval to the scheme and the Finance Ministry allocates the budgetted amount of the approved scheme to the Administrative Department who in turn transmits the approved scheme as well as the budgetted amount to the DPHE.

(b) The Head of the Directorate, the Chief Engineer, on receipt of such scheme and the budget allocation asks the Superintending Engineer concerned to submit his budget how does he wants to spend the money in a financial year against the approved scheme and accordingly the Chief Engineer allocates funds to him. The Executive Engineers prepare the working estimates, plans and prepare specifications of works under the guidance of Superintending Engineers. The Executive Engineer out of the annual development approved programme can approve estimates upto the amount Taka 25,000.00 and accept tenders upto Taka 1,00,000.00. If this amount is exceeded he sends to his Superintending Engineer and in turn to the Chief Engineer for approval of estimates, plans and specifications for amounts of competence of respective officers.

(c) On receipt of the approval/the EE, may call for tenders from the approved enlisted contractors of the category suited for the work and on the day of opening, he opens the tenders and prepares comparative statements. These statements after scrutiny are approved by the competent authority stated earlier. Usually the lowest tenderer gets the work and the Assistant Engineer is the man who as per approved plans, bill of quantities and specifications gets the work done by the contractor with the help of his Sub-Assistant Engineer and other staff. Either on partly completion or on fully completion of the work the Assistant Engineer prepares bills either running account bills or first and final bills for payment.

(d) Some times for smooth running of the work the officer-in-charge has to purchase certain articles from the open market and the cost is to book directly to the works.

(e) It sometimes becomes necessary for the Assistant Engineer to warn the contractor for doing works out of specifications or for excessive delay in execution. In that case the Assistant Engineer needs to write to the contractor mentioning the time, date, place and nature of defects he has observed for rectifications, giving a specific date by which the contractor must rectify as per the specifications and contract documents agreed upon by both the parties, i.e. the Government and the contractor. If the contractor does not abide

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by those instructions the duty of the Assistant Engineer is to report to the Executive Engineer for taking appropriate action as per contract document against the contractor and the Executive Engineer either cancels his tenders or takes other appropriate actions as per contract documents. (The Assistant Engineers are requested to go through one of the contract documents Bangladesh Form No. 2911 where a number of instructions were given how to get works done and what rules are to be followed).

In cases where the contractor leaves a work incomplete the Executive Engineer either himself or under authority from his superiors cancels the works of the contractor and incomplete works are measured by the Assistant Engineer in presence of the contractor who is invited to remain present and signs a paper agreed upon by both the sides. In cases the contractor does not turn up or does not send his representative to take measurement of such incomplete work the Executive Engineer by writing letters under registered cover to the contractor giving him a definite date may authorise the Assistant Engineer or may himself take the measurement of the works exparte and get the remaining work done departmentally or a fresh tender is called for the remaining work and can be done by some other agency at the cost of the original contractor.

(f) In certain nature of works it becomes difficult for the Assistant Engineer to supervise himself along with his Sub-Assistant Engineer and it sometimes becomes necessary to appoint Work-Assistants, Construction Inspectors, Peons and Night Guards on temporary basis for supervision and looking after the works and materials for a time till the works are completed. Such employees are called Work-Charged employees. Their pay and allowance of 2½% of the estimated amount are directly booked to the cost of works and those people are disbanded after completion of the schemes.

(g) In discharge duty of the Assistant Engineer he may sometimes find that his Department is doing works in favour of other Govt. Departments, Autonomous Bodies or even private party who may approach the Department for getting a special nature of works done through his Department. Such works are called "Works on Deposit Account" and under public works rule when the other agency is a department not guided by public works department (i.e. unlike Buildings, Roads and other Public Works Departments) they deposit the cash money or on Bank Drafts to the Executive Engineer against the estimates of the works they desire to be done through the DPHE. And the Directorate gets the works done as if it is his own and charges from the other department an amount of Taka 17% as departmental charge, audit and account charge, etc. etc. If the other department is a department guided by public works department they simply approves the estimates of the works and ask the DPHE to get the work done and raise debits against them. In such cases also the DPHE gets the works done as if it is his own department and charges an amount of Taka 8% departmental charge on account of audit and accounts and other miscellaneous expenditures.

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3. OFFICE RULES

(a) Lerve rules, disciplinary cases - disciplinary rules, pension - pension rules.

(b) Attendance, decorum and writing of C.C.R.

(c) Receipts and issues of letters

(d) Writing of letters to other offices, tour diary, tour programme, writing note book.

(e) Handling of confidential matters - urgent matters, special matters

(a) An Assistant Engineer has to deal with the leave cases of subordinates under him. Leave may be casual leave, earned leave on medical grounds and other leaves or quarantine leave of 21 days. In case any relation of the Govt. servant who live with him has been attacked either with small-pox, chicken-pox or cholera or other such diseases the Govt. servant is entitled to get 21 days earned leave called quarantine leave. Leaves are granted on different terms of conditions laid down in the Service Rule, Part II guiding services of Govt. servants of Bangladesh.

He is to deal with delinquent staff under him under the Efficiency & Discipline Rule 1960 (Revised). It is advised that the Assistant Engineers go through the Efficiency & Discipline Rules, 1960 Revised, in details and study it for himself so that he can effectively apply the appropriate clauses of rules for punishing the delinquent staff under him.

He will have to report about the pension cases of staff working under him. The pension rules are fairly complicated and requires careful study. The Assistant Engineers are advised to go through the details of Pension Rules. It is informed that it is their duty to notify the staff concerned more than six months before he attains the age of going to pension and allow him the leave preparatory to retirement. This leave will be an earned leave.

(b) The Assistant Engineer will regularly check the attendance of the office staff after their arrival and before the office hours are over. The Govt. Servants have to maintain all discipline and decorum in the office which every staff has to maintain towards his superiors and towards subordinates. In writing letters he will maintain the decorum with his superiors also with his subordinates. The language should be short, clear and polite. He may express his annoyance or disapproval but the language should be elegant & expressive.

(c) In the office of the Assistant Engineer he has to issue and receive letters to and from other offices. In this business all the letters received in a book called receipt register and issue letters to

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other offices recorded in a book is called issue register. In the issue register he has to maintain the account of service stamp used in every letter which is also recorded in a separate book are to be accounted for and monthly accounts of stamps alongwith stat onery articles and other paper are to be sent to his higher office.

Every year during the end of December he has to write confidential character rolls of his staff. There are definite forms which are to be sent to his superior in duplicate by the first week of January the following year.

(d) An Assistant Engineer is to record the tours he performs in the type of diary and whatever he observes, instructs, and information gathers are to be noted down in a note book officially issued to him by his superior office. He also requires to submit his advance tentative tour programme to his superiors by the end of the previous month. It is not absolutely necessary that he will follow the tour programme in to-to but he is required to follow the programme unless there is any great difficulty in it. The Assistant Engineer sometimes has to write letters to other offices, public representatives or to individual public. In writing those letters he is to maintain certain decorum. The letters should be very polite and his language should be simple. But on policy matter he should not write direct or make commitment to anybody for such matter without prior approval or discussion with Executive Engineer.

(e) In matters of handling confidential nature he is to maintain a record book, issue of confidential letters by himself personally and keep the confidential matters in his personal custody. Confidential matters are usually sealed in the envelope and a separate envelope is used to cover display of the matters. In the top of the envelope the person addressed to is to be addressed by name. In handling urgent and special matters it is advised that the Assistant Engineer should personally handle these things rather than relying upon the clerical staff because they sometimes may not understand the magnitude of urgency and of their special nature. In all technical matters and other urgent jobs he should personally make the draft and check letters before signing.

4. FINANCIAL RULES

(a) Powers with rank, financial sanctions

(b) Increase and decrease of work-non tendered items - revised estimates

(c) Survey report of materials, theft and loss of materials

(d) Purchases - contingent expenditures, tools and plants, repairs

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(e) Public auction of materials

(f) T.A. Bills, Pay Bills, Pre-Audit of Bills

(a) The most important rules in the function of the office of the Assistant Engineer are the financial rules. As you know a person is more responsible who spends than a person who earns and should have high sense of judgement in spending Govt. money. The sense of judgement is taught by the Govt. through rules and regulations. As Assistant Engineer you will spend the money of the Govt. under certain rules and regulations. If anybody makes mistake he not only makes the Govt. loser but makes himself also liable to punishment. Therefore, it is desired that the Assistant Engineers be very careful about the applications of financial rules. In the DPHE an Assistant Engineer cannot purchase anything out of Govt. money without prior approval from his superiors. To spend for the interest of Govt. works it is required that he will submit an estimate of foreseen and unforeseen expenditures to his superior and take advance of money and as per instruction of his superiors he will spend those and submit the vouchers after their entries in the measurement books along with the complete account and return the unspent money to his superior for adjustment. Before the complete account is submitted the Assistant Engineer remains liable for the amount so advanced to him.

(b) While executing works the Assistant Engineer may have to increase or decrease the works executed by a contractor. If the increase or decrease is of considerable amount he has to report to his superior for obtaining approval. Sometimes in some works he has to get it done which are essential but those are not covered by the bill of quantities of the work. In such cases if the items are too many and involve high expenditure he has to report to his superior and get his permission including negotiation of rates with the contractor and approval from the competent authority. If rates cannot be decided immediately it should be approved just after completion of work on the claim of the contractor by the competent authority. After the works are so done he has to prepare a revised estimate of the completed works showing the items of the tender and the non-tendered items separately and submit a report along with this as to why non-tendered items cropped up. After approval of the revised estimate he can enter the non-tendered items into the measurement book and submit the bills to the Executive Engineer for payment.

(c) The charge of stores of a Sub-division has with the Assistant Engineer. But he may engage his office clerk to keep store records also. The Assistant Engineer has to check the godown under him of Govt. materials and from time to time he has to physically verify the stores and examine the papers maintained by the

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clerk-in-charge. If he finds accumulation of unserviceable materials or useless materials or deteriorated materials he has to submit a report called survey report in duplicate in a form to his superior for auction sale or otherwise disposal of the useless materials. His superior on receipt of the survey report will get it processed and obtain the sanction for public auction or otherwise disposal. If any material is lost or thievery occurs of any Govt. materials the Assistant Engineer is required to immediately report to the Police Station giving a First Information Report simultaneously he is required to report to his Executive Engineer and the Superintending Engineer about the loss or theft even before verifying the account and amount. Then he is to conduct a complete enquiry into the matter and submit a report to his Executive Engineer. The Executive Engineer on receipt of such report may come to the spot and verify, examine and ascertain the liability of the loss and submit a report to the Superintending Engineer for action.

(d) The Directorate from time to time will allot some amount of money to him under the sub-head contingent expenditure, tools and plants, repairs, etc. The Assistant Engineer can purchase materials out of those funds directly from the market if the amount is below Tk. 20.00. If the amount exceeds he has to call for quotations and if the amount exceeds Taka 500.00 then he can request the Executive Engineer to call for tenders for purchase of those materials and tools and plants. In case of repairs he can only report to his superior with estimate for such repairs and after obtaining sanction the repairs can be done according to the financial rules.

(e) In cases of auction of Govt. materials the Executive Engineer will authorise him to conduct the public auction. In that case he will go to the spot accompanied by the Govt. auctioner, prepare a bid sheet as per proforma and every bid is to be recorded with names and addresses of the bidders. The detail is required to be known from his superiors.

(f) The Assistant Engineer being the drawing and disbursing officer of his subordinates is required to pass T.A. Bills, Pay Bills. If T.A. Bill is not drawn within six months from the month of journey it is required to be preaudited. In that case he is required to send to his superior for transmission to the Accountant General and the Accountant General after examining the bills send to the treasury or sub-treasury and he gets the money against the bills from the treasury or sub-treasury. In case of pay bill if it is not drawn within 3 years from the month of payment the bill is preaudited after investigation and in the same way encashed.

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5. RESPONSIBILITY OF ASSISTANT ENGINEERS

(a) In office maintenance, checking of note books

(b) Administration-follow up of works of subordinates

(c) Control of subordinate staff - good manager's job

(d) Issue of liveries to staff, etc.

(e) Maintenance of stores, accounts, registers

(f) Payment of rent, tax, rate, etc., electric bills, renewal of licences of vehicles, drivers, etc.

(g) Stock accounts, writing of measurement books and record keeping

(h) Coordination with departmental and outside offices - UNICEF/WHO/ local offices and public relations - contractors.

(i) Maintenance of accounts of imprest, temporary advance

(j) Postage stamp register, other registers

(k) Maintenance of buildings, structure and other Govt. property

(l) Transmission of various periodical information to higher authorities - others.

(m) Vehicle registration, maintenance, etc.

(n) Responsibility to his community - nation

(a) Efficient management of the office is the responsibility of the Assistant Engineer in doing so he is to face a number of matters which it is impossible to mention in a booklet form but an intelligent person easily can understand what are his responsibilities if some informations are given in nutshell. The Assistant Engineer is to check the activities of his staff very often. In entering into the office he is to see who is on his table or who is not and what the staff are doing. He is required to check notebooks of tubewell mechanics and Sub-Assistant Engineers and Overseers from time to time seeing what have been noted and whether they have correctly noted about the works and maintenance works.

(b) & (c) Each work given to subordinate staff must be followed up to see whether they have properly implemented or not. He should be very courteous but at the same time very strict in his principle. Thus

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he can become a good officer. There may be genuine grievances from his staff where he will give patient hearing and ventilate the feeling to superiors for their redressment.

(d) Now-a-days Govt. has granted liveries to the lower staff who are entitled to get at Govt. cost shirts, pants, shoes and umbrellas according to their grades and nature of jobs and the Assistant Engineer is to keep in record who has taken and at what intervals.

(e) The maintenance of store is entirely the responsibility of the Assistant Engineer although a clerk is directly in charge of the materials. Submission of monthly accounts, fortnightly and weekly and maintenance of registers like tubewell register, works register, etc. are the responsibilities of the Assistant Engineer.

(f) For the office of the Assistant Engineer he has to pay rent, tax, rate, electric bills, water bills and for his vehicle he needs to renew licences of the vehicles and driving licences of the drivers at Govt. cost at certain intervals as required. For any difficulty or for expenditure he is to consult the Executive Engineer and the account of expenditures are to be adjusted after having receipt of the bills of such expenditures.

(g) Account keeping with respect to the works contractorwise and tender-wise are the responsibility of the Assistant Engineer. When he records a measurement of work after its completion he can send those to the Executive Engineer for payment. As per rule the measurements are to be written by the Assistant Engineer in the M.B. (Measurement Book) himself. The measurements are recorded according to the language of bill of quantities of the works or as per language of the approved supplimentary tenders where applicable.

(h) An Assistant Engineer is often required to coordinate his activities with those of local people, UNICEF, WHO, public leaders and private individuals. In each case he has to play diplomatically.

(i) When an Assistant Engineer is allowed an imprest money he has to keep record of the imprest money and maintain an account of passing of bills from the imprest. He can again take the imprest money to get other works done. Imprest money is a fund of temporary advance and is required to be adjusted by paid vouchers.

(j) In his office he has to maintain a number of registers like postal stamp register, issue and receipt register of letters, register of books and stationeries, register of furniture, tools and plants, register of bicycles, register of tubewells and many other registers besides the register of materials.

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(k) Maintenance of Govt. buildings, structures and other Govt. property are the responsibilities of the Assistant Engineers. Occasionally he has to visit these and see whether while washing and repairing are necessary. On the roof top whether weeds grow or crack develop, leakage through the roofs occur etc. are to be checked from time to time and repair estimate submitted to his superior officers for proper maintenance of the buildings and structure.

(l) He has to regularly transmit periodical information to his higher authorities and sometimes to other offices too. In this case he is advised to hang some proforma in the wall of his chamber to remind of the type and nature of the information to be transmitted periodically. This will help him maintain this timely.

(m) Under him there may be bicycles, motor cycles and Govt. jeep and their regular maintenance like servicing, tunning, checking of mobile oil, distilled water, fuel, tyre conditions and outside cleaning are his responsibilities.

(n) Besides that the community in which he lives deserve something from him and he has certain responsibilities to the nation belonging to him. As a young engineer he has to see that relations are established with his neighbours, friends, subordinates, superiors and everybody around him.

6. <u>SUPERVISION OF CONSTRUCTIONS, INSTALLATIONS, ETC.</u>

(a) Procurement of departmental materials, issues to contractors rules involving in those - receipt back of materials - maintenance of site accounts.

(b) Inspection of contractor's materials, men, arrangements, tools and plants, safety measure, time of construction.

(c) Maintenance of site books - warning to contractors - transmission of information to higher authorities.

(d) Site inspection - cropping up of problems

(e) Progress reports

(a) The Assistant Engineer is responsible for supervision of constructions and installations. In doing so immediately after receipt of the copy of the work order or even before that he has to check the departmental godown and see whether materials are sufficient in his stock for the future works. If there is any shortage of materials he is to write

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to his superiors and submit indents in particular form and obtain materials for keeping in his store. When these materials are issued to the contractors a separate book or page of a book is require to maintain to show what materials are issued, what materials are returned by those particular contractors, what materials are utilized by them. These registers are called site accounts of materials register. These site accounts may be maintained with respect to a particular project or for an individual contractor. It is better to maintain for every individual contractor or individual contract. While submitting a running bill or a final bill he is required to submit an accounts of materials along with those bills.

(b) In execution of contract the contractors are sometimes required to supply materials. It is the duty of the Assistant Engineer to inspect those materials before use if they are as per the standard specifications. Unapproved materials should be removed by the contractor from the site at once. For that, quality and quantity of contractor's materials should be approved and recorded by the Assistant Engineer in work site book. If such people have been engaged by a contractor who do not behave properly the Assistant Engineer has the right to ask the contractor to withdraw the man from the work site. The arrangements of the construction, tools and plants, safety measures, etc. are to be examined by the Assistant Engineer at the work site from time to time or even before start of the work. The Assistant Engineer is required to ask from the contractor the time schedule for completion of a particular work and the Assistant Engineer may ask the contractor to follow the time schedule for the interest of the works. Department should also make work-schedule for each work in the line as the Chief Engineer suggested in his deliberation.

(c) The Assistant Engineer may ask the contractor to maintain a site inspection book in which the Assistant Engineer may write his inspection notes or instructions to the contractor, mild warnings also may be recorded in those books and if anything goes beyond control he is to promptly report to his superiors.

(d) If any problem crops up he may write in the site inspection book or even he may express his satisfaction of the work if the contractor does everything perfectly alright.

(e) The progress of works from time to time are required to be reported to his superior officers for their information.

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7. IMPLEMENTATION OF SPECIFICATIONS

(a) Study and understandings of specifications

(b) Change - violation - overlooking - negligence of specifications

(c) Improvement of specifications in subsequent works

(d) Ambiguous terms, simple and clear language, short and understandable specifications, etc.

The Assistant Engineer on receipt of work orders is required to go through the papers very very carefully specially the specifications because the contractor is required to follow the specifications and the Assistant Engineer is required to get the works as per specifications. It is a vital document for getting work done perfectly. The language of the specifications should not have any ambiguous word. It should be simple and clear, short and understandable avoiding unnecessary description. The change of specification is strongly prohibited. When a work order is issued, specifications cannot be changed or should not be violated. If there is any ambiguity or omission in the specifications which is not understandable either from the side of the contractor or from the side of the Assistant Engineer it should promptly be brought to the notice of higher authority and instructions may be sought how to rectify the omissions. He is a good Assistant Engineer who keeps note of such points which he found not workable in a particular specifications for the interest of works and in subsequent tenders he points out to his superiors to change the specifications to suit a particular nature of work for its improvement or modification. The suggestions are always welcome.

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TRAINING PROGRAMME
FOR
ASSISTANT ENGINEERS
OF
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH

SUBJECT: STORES MANAGEMENT PROCEDURES
STORAGE OF CEMENT & OTHER MATERIALS
MAINTENANCE OF VEHICLES

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MANAGEMENT PROCEDURE:

The definition of scientific management as given by Frederick Winslow Taylor, of the U.S.A. in his own words explain both what management is not, and what it is.

'Scientific management' is not any efficiency device. It is not a new system of figuring costs; it is not a new system of paying men; it is not holding a stop-watch on a man and writing things down him; it is not time study; it is not motion study nor an analysis of the movements of man; it is not any of the devices which the average man calls to mind when scientific management is spoken of. In its essence, scientific management involves a complete mental revolution on the part of the working man engaged in any particular establishment or industry.

Management is an Art

That is an attidude of mind rather than a bundle of techniques is worthy of further emphasis. The term 'scientific management' suggests, unfortunately that management is a science. True it is that a set of basic principles is now well established - and can be taught. True it is, too, that scientific management makes use of scientific knowledge. But it is not in itself a science, if science be taken to mean the exploration and explanation of the physical universe by observation and experiment, inference and deduction. It is, instead, an art approached in a scientific temper.

Its classification as an art is justified by the prime importance, in management, of achieving desired ends by means of the collective effort of a group of human beings. There are many other facets of management, but this fundamental requirement to organise human beings is its distinguishing feature, it explains, for example, the value attached to leadership as a quality in the good manager. Whether it be a shopkeeper with one assistant, a section-leader in a consulting engineer's office, a contractor's agent on a construction site, a commander of an army, a prime minister of a Government - whereever, in fact, tasks have to be allocated to subordinates, there also is needed this art of handling people so as to get from them their best work relevant to the job in hand. To do so inevitable involves consideration and assessment of imponderables, for not only is there infinite variety of human beings but each individual has his own range of variation inemotional reaction, personal inclination and intellectual strength.

Two Principle Functions:

In the higher realms of management, two principle functions are involved. First, there is the formulation of purpose, the definition of the goal towards which effort is to be directed, and second, there is the creation of facilities and environment which encourag men and women of varied ability and inclination to work together harmoniously towards that goal. If any business enterprise is to succeed, it must operate as a unity. To create and maintain that unity is a paramound responsibility for top management.

What does all this mean for the young engineer? To begin with, he should reject outright the familiar aphorism that 'a good manager is born, not made'. The implication here is that study is a waste of time, that only the man with an in born flair for it can achieve managerial rank. The argument against management training for engineers alleges that, on the one hand, engineers should strive after increased technical knowledge and experience and so enhance their value to the community as highly skilled specialists; and, on the other hand, that the employer can in any case buy all the managerial abiloty he needs by appointing appropriate new comers to his staff.

Training and Study:

The argument against management training for engineers can also be rebutted by re-calling that not so many years ago, the engineering graduate was suspect to the employer who had struggled to success by virtue of natural ability and un-ramitting practical efforts. Today, by contrast, most employers demand engineering qualifications of high theoritical merit. In the engineering field it has thus come to be recognised that for those who can benefit by it a sound theoritical basis will enable a man to develop move fully his potential abilities. Exactly the same consideration can be applied to the field of management. Rejection of the slick and erroneous judgement that a good manager is born not made, should thus be followed by acceptance that 'a good manager is both born and made'.

Wisdom and Knowledge:

To study, appraise and make sound judgement, upon these external factors requires a mind which has acquired wisdom as well as knowledge, which has breadth as well as depth. Any professional engineer treading the path of management will inevitably acquire these qualities in some degree as his personality develops with variety of experience. But he will doubtless do so to a greater degree if he is aware as a young man of the qualities which will in later life be required of him before he can satisfy his managerial ambitions.

Breadth of knowledge and maturity of judgement, given innate ability, can be developed through wide reading, foreign travel, intermingling with persons in other walks of life and participation in activities remote from the daily employment. Perhaps, too, the best result can be obtained by embarking upon these activities as the natural expansion of a well-balanced personality towards a greater interest in world affairs and a fuller enjoyment of life.

The Engineer-in-Management Administrator and Technologist:

To the recently qualified engineer it may be a depressing thought to discover that yet further study awaits him. Cultivation of an attitude of mind is one thing but to tackle yet another new body of knowledge is another, more daunting, prospect. The trained mind, however, once embarked upon the task, will find it easy by comparison with the everage engineering curriculum. The professional mind, moreover, never stops all through life studying, contemplating and broadening in knowledge and wisdom. By taking an early interest in scientific management, a stronger sense of purpose can be engendered into that natural tendency.

In the less developed countries where technology has been desperately needed to make the transition from the static to the dynamic society, and industrial maturity, there is no psychological bar against the technologist rising to the highest level, and he does in fact do so to a much greater extent than in the United Kingdom. In Russia, for example, or Mexico, the status of the technologist ranks very high because his value to the community is widely recognised. He, in turn, reacts to that esteem by acceptance of responsibility for leadership, by a sense of mission rarely found today in the mature nations.

<u>STORES MAINTENANCE:</u>

In connection with maintenance of stores the following CPWA codes are quoted:

CPWA Code P-96: The general administration of all the stores of a division is vested in the Divisional Officer, on whom primarily devolves the duty of arranging in accordance with such rules and instructions as may have been issued by Government for (i) the acquisition of stores, (ii) their custody and distribution according to the requirement of works and (iii) their disposal.

P-97: Government officers entrusted by the Divisional Officer with the care, use or consumption of stores, are responsible for maintaining correct account, records and preparing correct returns in respect of the stores entrusted to them.

P-98: All transactions of receipts and issues should be recorded, strictly in accordance with the prescribed rules or procedures, in the order of occurrence and as soon as they take place.

99-(a) The accounts of stores are based on the fundamental principle that the cost of their acquisition should be debited to the final head of account, concerned or the particular work for which they are required, if either of these can be determined at once, otherwise it should be kept in a suspense account pending clearance, as the materials are actually issued by debited specific heads of account or works.

99-(b) In accordance with this general rule, the cost of the supply of all stores required as tools and plant for the general use of the Division, is debited at once to the minor head "Tools and Plant" Subordinate to the major head under which such charges of the division are classified and special items of tools and plant, which are required not for general purposes but for a specific work, are debited to that work.

99-(c) In the case of other materials, when purchases are made for the requirements of works generally, the cost is accounted for under the suspense head "stock".

100: The classifications of stores are as follows:

1. Stores debited to suspense:

   (a) Stock

2. Stores debited to final heads of account:

   (a) Tools and plant
   (b) Road-metal
   (c) Materials charged to works

General: The stock of a division is sometimes kept in a single godown or yard in the charge of a store-keeper or other officer, or each Sub-divisional officer/Assistant Engineer, may have a separate stock in his charge, either at his headquarters or scattered over the sub-division in the direct custody of subordinates or other sectional officer, who are directly responsible for maintenance of accounts. The stock accounts are required to be maintained by the Sub-divisional Engineers/ Assistant Engineers under whose custody such stores are kept.

Receipt:

Materials may be received on stock from the following sources:

Quantity A/c

(a) Supplies

(b) High Commissioner for Bangladesh in U.K. and other countries

(c) Other Divisions or department (including Government workshops),

(d) Works, building etc.

104: In all cases there should be proper authority for the receipt by the store-keeper or S.A.E. concerned of materials to be brought on stock. This authority should be given in writing by the Divisional Officer (i.e. Executive Engineer) or, if so authorized under local orders.

All materials received should be examined and counted, or measured, as the case may be when delivery is taken. The record of the detailed count, or measurement should be kept in the M.B.

The total or quantity received should be simultaneously entered in the register of stock receipts (Form-8). Such acknowledgement as may have to be given to a supplier for stores received from him can be signed by the divisional or sub-divisional officer (Assistant Engineer). Any certificate that the store-keeper or S.A.E. concerned may be called upon to record in respect of the receipt of stores, for this or any other purpose should be in the following form:

Received on ... .and duly recorded in the register of stock receipts See also page No. .... of M.B. No.

Date ... .   Signature ....

Issue:

Materials from stock may be issued for the following purposes:

(a) For use on works either by issue to contractors or direct to works.

(b) For despatch to other sub-divisions, divisions or departments.

(c) For sale to contractors, employees, other persons or local bodies on competent authority's orders.

106: The stores should be issued only on receipt of an indent (Form-7) signed by the divisional or sub-divisional officer/Assistant Engineer. But when a sectional officer has to issue stock materials for the requirements of works under himself the use of this form may be dispensed with, if the sectional officer has been authorized under local orders to draw, such materials from his stock up to any assigned limit not exceeding the provision made for materials in sanctioned estimate.

107: Indent:

Indents should be filled up carefully as all subsequent accounting depends upon it. In the col. "Head of accounts, etc." besides entering the name of account head to which the issue of stores is debitable, full name of division and offices to which stock is to be issued and of contractors, employees, other persons of local bodies to whom it is authorised to be sold, should be added in all cases in which stores are ordered to be issued otherwise than for the requirements of works within the division. The last col. headed "Name of work, etc." should be filled in only when the stores are required for works within the division and in such cases the full name of the work as given in the estimate should be entered as well as the name of the contractor from whom the value is recoverable.

111: Monthly abstract of receipts and issues:

The receipt and issue transactions of the entire materials should be abstracted monthly in a single "Abstract of stock receipts" (Form-9) and in single "Abstract of stock issues" (Form-10). These forms should be posted in the sub-divisional office/A.E.'s office, from the register of stock receipts and stock issues (from 8 entries being made only in respect of quantities).

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112: When abstacting the transactions recorded in the register of stock receipts and stock issues, care should be taken to observe strictly the prescribed accounts classification. It is not sufficient to enter the name of the major head affected but the minor and detailed heads should also be stated, and as well as the additional particulars to be mentioned.

Value Accounts:

(a) Payment for stock received

Bills for supplier should before, payment, be examined and charged to the accounts of works by transfer credit to the "Purchase" account the payment to suppliers are governed by the rules as payments to contractor for work done. In the case of lump sum contracts, every bill or other demand for payment should as far as possible, set forth the unit rate at which payment is to be made.

(b) Recoveries for stock issued

(i) Issue rate:

118: An issue rate is assigned to each new article as it is brought on stock. This rate is fixed on the principle that the cost to be charged to works on which the materials are to be used should approximately equal the actual cost of the stores and that there may be no ultimately profit or loss in the stock accounts. It should provide, beyond the original price paid for carriage and other incidental charges, if any actually incurred on the acquisition of stores.

119. Normally the issue rates will remain constant throughout the half year, but as purchases are made or contractor for the supply of materials are entered into variations in cost should be watched, and if these are appriciable, issue rates, may and in important cases shall, at once be raised or lowered, as the case may be.

If the issue rate of an article is appreciably less than the market rate, the following precautions should be taken:

(a) Issues to contractors and sales shall be made at market rates.

(b) Issues to other divisions and deptt. may be made at a rate higher than the issue rate.

Half Yearly Balance Return

The total quantities of the receipts and issues of each article of stock, as recorded in the monthly abstracts, (Form 9 and 10) should before the abstracts are transmitted to the divisional office, be

.../

posted in the half yearly balance return (Form 11), in the columns provided for the month concerned both under "Receipts and Issues". As soon as the receipts and issues of the last month of the half year are posted the closing balance should be worked out and entered both in column 21 "closing balance carried forward" of the return for the half year and in column 6 "Balance brought forwarded" of the return for the next half year.

Ledger:

The maintenance of a continuous ledger for each article of stock is not necessary. It is permissable, however, to use loss cards or leaf ledger in suitable forms, where this system is adopted the following instruction should be observed:

(a) The card or leaf ledgers should be written up in respect of quantities only, but if values are entered therein for any purpose, they will not be recognised for purpose of accounts.

(b) They should not replace the register of stock (Form 12) but should on the other hand be reconciled there with at convenient intervals.

(c) If the maintenance of the register of stock receipt and stock issues (Form No. 8) is considered unnecessary they may be dispensed with, provided that suitable arrangements are made for the abstract of stock receipts and stock issues (Form 9 and 10) to be written of, as transactions takes place either by a responsible officer or on the authority of written reports signed by such an official and supported by necessary vouchers.

(d) The ledger, if necessary may be kept in a convenient position in the store godown, but they should be kept locked the keys being in the custody of the person responsible for making entries therein.

(e) The Department is maintaining the accounts of UNICEF materials in a particular kind of ledger sponsored by the UNICEF authority in which the particulars of receipt, issue to different deptts., contractors, etc. are chronologically recorded in the cols. provided for in the ledger. This type of ledger is being maintained in absence of opening of the stock accounts as per codal rules for which attempts are being taken to open the same in addition of the UNICEF Ledger.

It is a clear understanding that stores should be recorded clean in UNICEF Ledger so that anybody either from DPHE or UNICEF visits Subdivision may look into upto date records. Maintenance of records and cooperation with UNICEF staff are a vital part of our Agreement (Plan of Operation). The system of this type of maintenance of ledger, it seems, is sufficient guide for all concerned.

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H.R. challan and gate pass

All these are required in stores, maintenance specially issue of Govt. materials. Gate Pass is the exit certificate to be produced at the gate when materials are taken out. Challan are required when materials are issued from stores to stores or from one division to other division or subdivision and vice versa. H.R. are required when materials are issued to contractors.

Despatch Schedule

Despatch schedule is a schedule which is followed for despatching materials to the subdivisional godown for execution and maintenance of different scheme. Two types of despatch schedule for materials and despatch schedule for spares. The despatch schedule of spare was prepared by a sub-committee consisted of experts for all spares requires for repairing of hand tubewells despatch schedule of tubewell spares are enclosed (Vide Appendix 'A') for explanation.

Verification of stock

The periodical verification of stock at least once in a year is required to be conducted and result theirof should be reported to the divisional officer for orders. As soon as discrepancy is noticed, the book balance should be set right by the verifying officer treating a surplus as a receipt and a deficit as an issue, with a suitable remarks.

The value of stores found surplus should be created at once as a revenue receipt or a receipt on capital account as the case may be. The value of a deficit, however, not be debited to final heads, but kept under "Misc. P.W. Advances" pending recovery or adjustment under orders of competent authority.

One identical one and very important document for materials issue and adjustment.

Physical verification of stores by UNICEF personnel

As per Plan of Operations, there is provisions with the UNICEF authority to conduct physical verification as and when required. It is observed that the UNICEF authority uses to conduct physical verifications of UNICEF items of the stores and the results of the verifications are recorded in the ledger maintained in the divisional and subdivisional store.

The system of double physical verification both by the DPHE and UNICEF is effectively found suitable for the security of UNICEF materials.

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Storage Facilities

To executive any Engineering Project, the availability of storage facilities should not be over looked. In general storage facility indicates a clear understanding of keeping of different types of materials at a certain place which provides safety, upkeepment of materials and easy transaction facilities to the places where the works are to be executed. To satisfy the above requirements construction of godown, open stack yard, protection wall may be discussed briefly.

This paper will not cover the structural details of construction since it is known to our fellow engineers well. An attempt to remind some essential aspects for construction of godown are classified as follows:-

Site selection

Site for construction of (store godown) should be raised to a level higher than normal flood level. The location of godown demands a reasonably short distance from the nearest railway, river jettey and highway, although this facilities may not be always available.

Protection from dampness

For specific materials such as cement, steel specials, leather materials protection from dampness and weathering should be made available.

Stacking of materials

In general stacking should be made in such a way that will provide opportunity to count and verify the stock at any moment by the varifying officer. Stacking of all materials should be made on a level ground to avoid damage of cement bags, bending of pipes etc. special care should be taken in stacking of PVC pipes and strainer which are sensitive to sunlight. Pipes and strainers should be stacked layers by layer.

Storage in covered shed

As discussed above PVC materials may be damaged by sunlight. It needs a covered shed for storage. Besides M.S. rod, M.S. specials tubewell spare parts, should preferably be stored in a covered shed to protect from rain.

Storage in open yard

G.I. pipes, A.C. pipes and specials may be stored in open yard but on a plane, clean and leveled ground.

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Protection and security

The most important factor of storage is to provide adequate protection and security of materials which necessiates the construction of boundry wall and provision of guards for 24 hours.

ORGANISATION OF MAINTENANCES STORES

Functions of Executive Engineer

As per CPW code the function of E.E. can be stated as follows:

This term is applied to an executive officer of the public works deptt. who is not subordinate to another executive or disbursing officer of the deptt.

The divisional officer is the primarily disbursing officer of the division and all realisations and payments on Govt. account made by his subordinates are made on his behalf and on his responsibility. The officer is personally responsible for the money which passes through his hands and for the prompt record of receipts and payments in the prescribed account as well as for the oorrections of the account in every respect.

The disbursing officer should check all the entries in his cash book as soon as possible after the date of their occurance and he should initialy the book, dating his initials after checking.

It is an important functions of the divisional officer to keep a constant watch over the progress of expenditure, as he is ultimately responsible for keeping the expenditure within the allotments for the division. He should accordingly keep himself informed of such circumstances as may affect the progress of expenditure, in order to take early steps for obtaining extra fund or surroundering probable savings as may be necessary.

Assistant Engineers

This designation is applied primarily to an official, whether a gazatted officer or not, who hold the charge of a recognized subdivision in subordination to a divisional officer but when the immediate executive charge of any works or stores has not been constituted into a regular subdivisional charge but is held by the divisional officer himself the latter is also treated as subdivisional officer in respect of such charge.

Sub-Assistant Engineers

This designation is used to describe those officials, usually non-gazatted subordinates, who are placed in responsible executive charge of works or store under the order of the officer in charge

.../

of a recognised subdivisions and the accounts of whose transactions are therefore, ultimately incorporated in those of the subdivisions.

Function of S.A.E. and S.K.

When issuing materials from stock the storekeeper or S.A.E. should examine the indent and sign it in the space provided for the purpose after making suitable alterations (attested in each case by his dated initials) in the description and quantities of materials if he is unable to comply with the indent in full. He should then prepare and sign the form of the invoice attached to the indent accordingly to the supply as actually made and simultaneously make entry in his register of stock (Issue Form 8). The indent should be returned at once to the indenting officer and the signature of the officer receiving the materials should be obtained, as soon as possible, on the invoice which should be trdated as a voucher in support of the entry in the register.

When making entries in the register of stock issues the storekeeper should pay particular attention to record in the column headed "To whom issued" and "Head of Account" the full particulars as given in the last two columns of the indent or as otherwise known to him.

STORAGE OF CEMENT

Cement was, for many years conveyed between the place of manufacture and the site of its use by barrels, or sockets. These containers give way to steel drums, for export conveyance and to paper bags for short-distance sea and land transport. For small works the paper bag will, no doubt, continue to be used for a long time to come, as inspite of its cost, it is easy to handle and may be thrown away after use.

The cement must be protected from wind and rain during the processes of transportation and storage. It is of course important that stocks of cement in store shall be used in order of receipt, to avoid loss of strength through partial setting under atmospher condition.

Cement must be stored in a dry covered shed, preferably on a platform about 6" above the ground level, and away from walls, and protected from every source of moisture to prevent its deterioration.

Construction of cement godown

Construction of cement godown is nothing but construction of godown with some special attention regarding dampness and water proof arrangement. The cement godown after construction must be dry in

.../

atmospheric condition.

Stacking of cement

Cement should be stacked over platform about 6" above the floor level so that no dampness detoriate the qualities of cement. The cement should be stacked in a godown which is completely dry and water proof. The average height of cement stacking is 10 (ten) bags and but must not exceed 13 (thirteen) bags.

Routinewise restacking of cement

To minimise deterioting of the qualities of cement due to long storage the cement bags should be restacked by turning the bottom layer at upper and vice versa and also over turning each bags after certain interval.

MAINTENANCE OF VEHICLES

For all development works transport is a must for its proper execution, supervision, maintenance and routine checking. In DPHE, almost all the engineers in all level associated with development works are provided with vehicle. Sinking and resinking of 160,000 tubewells in rural areas of Bangladesh is one of biggest UNICEF sponsored scheme in the works and major task now being executed by DPHE. In the scheme under master loan agreement betwen Govt. of Bangladesh and UNICEF about 60 jeeps, 30 micro-bus, 30 trucks, 5 pickup and good number of motor cycle and bicycle were loaned to DPHE for supervision of the scheme.

Master Loan Agreement covering UNICEF Vehicles

The master loan agreement between Govt. of Bangladesh and UNICEF cover all vehicles released to the respective Ministry for all UNICEF assisted programme in Bangladesh includes the following terms and conditions:-

1. The vehicles are and will remain the absolute property of UNICEF, unless and until title thereto has formally been transferred to the Government.

2. The vehicles will be registered or licensed by the Government to operate in accordance with the laws of the country.

3. The Government will at all times and in all circumstances hold UNICEF harmless from claims or suits of third parties arising from accidents or other causes involving the vehicles.

4. The vehicles will be solely used for the purpose of the project as specified in the release indent, and will not be diverted to other projects or used for purposes other than those set forth in the relevant plan of operations without the written consent of UNICEF.

.../

5. The Government will protect the capital investment of UNICEF against loss through accident, fire, theft or vandalism and will reimburse to the extent of depreciated value of the vehicles at the date of loss. The depreciated value will be determined by UNICEF on merits of each case. In the case of accident to or loss of a vehicle, UNICEF will be notified immediately and this notification will be followed by a detailed report.

6. The costs of operation, maintenance and repair of UNICEF vehicles are to be borne by the Government, and the Government will arrange to provide maintenance and repair services for these vehicles acceptable to UNICEF. This is to minimise the loss of vehicles services to UNICEF assisted programme and to hold Government and UNICEF transport costs to a minimum.

7. Vehicle control records will be maintained in accordance with mutually acceptable procedures. Such records will be made available for inspection, as required, by UNICEF.

8. The Government will furnish to UNICEF a quartely report on the vehicles.

9. In the event of any breach of the terms of article 4 above, UNICEF may, its discretion, withdraw any vehicle/vehicles involved.

10. In the event of vehicles becoming obsolete or unserviceable, UNICEF may at its discretion dispose of the vehicles by sale or by transfer of title to Government. The funds obtained through sale of the vehicles shall revert to UNICEF.

<u>Guidelines on the procedure of maintenance and upkeep of UNICEF programme vehicle</u>

All UNICEF vehicles in operation with Government/UNICEF assisted projects are on loan to the Government. They are covered by the Master Loan Agreement signed between the recipient Ministries and UNICEF.

Under the terms of the Master Loan Agreement, among other things, Government is presponsible for the following:-

1. Registration of the vehicles, in the name of UNICEF.

2. The cost of operation, maintenance and repairs of vehicles

3. Forward to UNICEF quartely vehicle reports

4. In case of accidents, forward accident reports to UNICEF immediately

.../

help the Government to overcome part of the acute shorgage of vehicle spare parts in the country, UNICEF imports, from time to time, limited quantity of vehicle spare parts to assist the Government to keep the vehicle in operation at all times.

Programme vehicle users can request for the spare parts for use in UNICEF vehicles alloted to them, in the indent form "Indent for UNICEF vehicle spare parts furnishing the full particulars as called for therein.

PREVENTIVE MAINTENANCE SERVICE GUIDE FOR LIGHT PETROL ENGINE VEHICLES

For proper maintenance of light petrol engine vehicles one standard service guide (Appendix B) is to be followed strictly for good service, safety and long life of light petrol engine vehicle

TEMO

"T" for transport, "E" for equipment, "M" for maintenance and "O" for organisation, i.e. TEMO is the abbreviation of Transport Equipment Maintenance Organisation.

Once the TEMO is established the monthly preventive maintenance, repairs and reconditioning of assemblies will be the sole responsibility of the TEMO.

HOW TEMO WILL FUNCTION

DACCA

1. One central Unit Assembly Reconditioning Centre to provide sufficient quantity of reconditioned assemblies to meet the requirement. Also to provide body, chassis, accident repairs and painting.

2. One Static Maintenance Unit to perform monthly preventive maintenance for vehicles operating within 25 miles radius.

3. Five Mobile Maintenance Units will operate in predetermined territories and provide monthly preventive maintenance to approximately 40-50 vehicles per MMU per month. Each vehicle within 15-2- miles of the service points will attend for maintenance.

4. One central parts warehouse for storage of all new and reconditioned vehicle parts and assemblies.

COMILLA, RAJSHAHI AND JESSORE

Each station will have the following:

1. One Auxiliary Unit Assembly reconditioning centre to supplement Central Unit Assembly Reconditioning Centre production and work in similar fashion except that only smaller unit reconditioning will be done to meet the needs of locally operating maintenance units.

.../

2. One static Maintenance Unit to carry out monthly preventive maintenance for vehicles operating within 25 miles radius.

3. Five Mobile Maintenance Units will operate in predetermined areas and provide monthly preventive maintenance to approximately 40-50 vehicles per MMU per month. Each vehicle within 15-20 miles of the service points will attend for maintenance.

PROCUREMENT OF UNICEF SPARES

It has already been mentioned in the master loan agreement that the cost of operation maintenance and repairs of UNICEF vehicles are to be borne by the Government. But in case of non-availability of spares in local market, the same may be obtained from UNICEF stock if available, provided the quarterly progress report are furnished properly. UNICEF makes available the spare parts for use in UNICEF vehicles on loan. The individual vehicles users can submit requisition for spare parts in the chart form "Indent for UNICEF vehicles spare parts" (Appendix C) furnishing full particulars as called for in the form.

QUARTERLY VEHICLES REPORT ON UNICEF VEHICLE

Under the Master Loan Agreement covering UNICEF vehicles loaned to Govt. the Govt. will furnish to UNICEF a quarterly report on the vehicles indicating:

(a) Licence number or fleet number

(b) Make, model and serial number

(c) First year in service

(d) Total mileage

(e) Condition

(f) Days out of service since last report

(g) Reason being out of service

(h) Cost of maintenance and repairs etc.

The above said quaries along with other wantings are recorded in a form "Quarterly vehicle report on UNICEF vehicle" (Appendix "D").

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INSTRUCTION TO BE OBSERVED IN THE CASE OF ACCIDENT

UNICEF already circulated the following information for observation in case of accident.

1. Give every possible assistance to arrange Medical Treatment and Transport to injured persons.

2. Note time, date and place of accident.

3. Note circumstances such as road conditions, width of the road, weather condition, load, vehicles speed and tyre of vehicle.

4. If other persons or vehicles are involved, obtain driver's name, licence number, address and insurance company of the driver of the other vehicle. Give your/driver's name, licence number, UNICEF address and insurance company to the other driver involved. Obtain names and addresses of witnesses and injured persons.

5. If other persons are injured or damages to the other vehicle or property, a police report MUST BE MADE.

   Provide the police with the following information:-

   (a) Your name
   (b) Your driving licence number
   (c) The address of UNICEF, Dacca
   (d) The insurance company that the vehicle is insured with and the insurance certificate number.

6. Inform Dacca by cable this to be followed with two copies of the completed accident and description of how accident occurred.

7. Under NO CIRCUMSTANCES are offers of money to be made or any negotiations or deals entered into.

8. The Dacca office will handle all claims in connection with accidents.

9. No repairs should be carried out until instructions to do so are received from Dacca.

LOG BOOK

Log book is the record register for furnishing detail information showing mileage, timing users, signature, particular of journey, information of lubricants and fuel etc. for each trip as per CPW code.

This book should be furnished properly on daily basis. Any discrepancy maintaining log book officer concerned will be held responsible for misappropriation of public money.

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UNITED NATIONS CHILDREN'S (UNICEF)
DACCA, BANGLADESH

PREVENTIVE MAINTENANCE SERVICE GUIDE FOR LIGHT PETROL ENGINE VEHICLES JEEPS, VOLKSWAGEN

OPERATION	1.5 1	3 2	6 4	9 6	12 8	15 10	18 12	KM Miles	In thousands
Chassis Lubrication	X	X	X	X	X	X	X	Continuing every	3,000 KM 2,000 miles
* Change Engine Oil	X	X	X	X	X	X	X	" "	" "
Change Engine Oil Filter	X		X		X		X	" "	6,000 KM 4,000 miles
Clean Oil Strainer (VW)	X			X			X	" "	9,000 KM 6,000 miles
Clean Fuel Filters	X	X	X	X	X	X	X	" "	3,000 KM 2,000 miles
Service Aircleaner	X	X	X	X	X	X	X	" "	" "
Check All Oil Levels-Engine, Gearbox, Transfer Case Differential	X	X	X	X	X	X	X	" "	" "
Change Gearbox Oil	X			X			X	" "	9,000 KM 6,000 miles
Change Transfer Case Oil	X			X			X	" "	" "
Change Rear-Front Differential Oil	X			X			X	" "	" "
Check Fluid Leve in Battery	X	X	X	X	X	X	X	" "	3,000 KM 2,000 miles
Check Fluid in Brake Master Cylinder	X	X	X	X	X	X	X	" "	" "
Service Cooling System	X	X	X	X	X	X	X	" "	" "
Service Tyres and Adjust Wheel Bearings	X		X		X		X	" "	6,000 KM 4,000 miles
Check Brake Operation and Pedal Free Play	X	X	X	X	X	X	X	" "	3,000 KM 2,000 miles
Dry Aircleaners-Replace Element						X		" Each	15,000 KM 10,000 miles

* Changer per mileage/KM shown or every 60 days, whichever occurs first.

more-2

OPERATION	1.5 1	3 2	6 4	9 6	12 8	15 10	18 12	KM Miles		In thousands
Check Clutch Pedal Free Play	X	X	X	X	X	X	X	Continuing	every	3,000 KM 2,000 miles
Check All V-Belt Tensions	X	X	X	X	X	X	X	"	"	" "
Road Test Including a Check of All Instruments, Lights Controls	X	X	X	X	X	X	X	"	"	" "
Engine Tune-up	X	X	X	X	X	X	X	"	"	" "
Adjust Tappet Clearance(NOT SIX CYLINDER JEEPS)	X		X		X		X	"	"	6,000 KM 4,000 miles
Tighten Cylinder head Bolts	X					X		"	"	15,000 KM 10,000 miles
Tighten All Body Bolts	X			X			X	"	"	9,000 KM 6,000 mile
Check Brake Linings			X		X		X	"	"	6,000 KM 4,000 mile
Check Exhaust System for Leaks			X		X		X	"	"	" "
Check Axle U-Bolt Torque	X		X		X		X	"	"	" "
Cgeck Shock Absorber Mountings and Bushes			X				X	"	"	9,000 KM 6,000 mile
Check Front Rear Springs-Bushings			X				X	"	"	" "
Check Charging and Starting Circuits			X				X	"	"	" "
Check Tie Rod Ends for Security and Play	X		X				X	"	"	" "
Ball Joints—Check Play			X				X	"	"	" "
Check All Dust Covers Sleeves and Seals	X		X				X	"	"	" "
Check Steering for Play and Leaks	X	X		X			X	"	"	6,000 KM 4,000 mile
Check All Oil Seals for Leaks	X		X				X	"	"	9,000 KM 6,000 mil
Change Spark-Plugs and Contact Breaker Points						X		"	"	15,000 KM 10,000 mile

Lubricants to be used: Engine Oil-S.A.E.40 or 30 Gear Oil-S.A.E.90 Grease-Multipurpose For more specific and

APPENDIX - C

The Transport Section
UNICEF
150/A, Road No. 13/1
Dhanmondi R.A.
Dacca-5

INDENT FOR UNICEF VEHICLE SPARE PARTS (EXCEPT VW)#

UNICEF Vehicle Fleet No.__________, Registration No.________________

Make________________, Model____________, Mileage/Kilometer Reading__________

is in need of the following spare parts. It would be grateful if you would inform me of the availability of these items in UNICEF stock at an early date.

As required by clause 8 of the Master Loan Agreement covering UNICEF vehicles, the Quarterly Vehicle Reports * have been / are being submitted to UNICEF District Office.

* Delete which is inapplicable.

Particulars of the spare parts are:-

Item No.	Full description of spare parts	Qnty.	These worn out parts were previously installed	
			Date	Mileage Reading

Full address:-

____
____
____

Signature____________________

Name in
block letters________________

Designation__________________

Please give correct code of parts required or an adequate description.

Use appropriate Indent form for Volkswagen (VW) vehicles.

Name of Sub-Division : ______________

No. of Tubewells : No.6 ______

No.4 ______

Total : ______

	Name of materials		Yearly requirement	Delivery * Schedule			
				Jan to March	April to June	July to Sept.	Oct. to Dec.
1	2		3	4	5	6	7
1.	Bucket No.	6					
		4					
2.	Seat Valve No.	6					
		4					
3.	Barrel No.	6					
		4					
4.	Head Cover No.	6					
		4					
5.	Base No.	6					
		4					
6.	Handle No.	6					
		4					
7.	Piston Rod No.	6					
		4					
8.	Plunger No.	6					
		4					
9.	Valve Wt.	6					
		4					
10.	Washer No.						
11.	G. I. Screw						
12.	Nuts & Bolts	2½"x½"					
		2½"x⅜"					
		3½"x½"					
		2"x⅜"					
		3"x⅜"					

______/PQ

APPENDIX -

QUARTERLY VEHICLE REPORT ON UNICEF VEHICLE

Date of Report__________

Quarterly report for________ quarter. Vehile Fleet No__________Vehicle Regn.______

Vehicle assigned to ________________________________ Location______________

Name of driver__________________ Speedometer reading 1st day of the quarter______

Speedometer reading last day of the quarter_________Miles/Kilometers done______

Miles/Kilometers per gallon of petrol________ Preventive Maintenance Inspection:____

Dates____________Mileage Reading_________ Days out of service since last report____

Reasons:____

____

____

General condition of the vehicle: Good ☐ Fair ☐ Requires repair ☐

Explain:____

____

OPERATING EXPENSE	MAINTENANCE EXPENSE
Qnty. of fuel used_____gals: Cost_______	Qnty of oil changed________ Cost_______
Qnty. of oil added_____pts. Cost_______	Oil filter changed ________ Cost_______
	No. of preventive maintenance ________ Cost_______
Total Cost=======	Total Cost : ======
Average operational cost per m/k _______	Average maintenance cost per m/k_______

REPAIR EXPENSE

Labour Cost_______

Spare Parts & supplies Cost_______

Total Cost =======

Average repair cost per m/k __________

VEHICLE ACCIDENTS SINCE LAST REPORT ______

Repair labour cost ______

Spare parts & supplies cost ______

Total cost ======

==

Comments:____

____

____

____

Signature of reporting officer______________________

Name in block letters______________________

Designation ______________________

Project ______________________

____/PQ

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : SINKING AND RESINKING OF HAND TUBEWELLS

Matiar Rahman
Executive Engineer, DPHE
Programme & Coordination Division
Dacca.

MARCH 1975

SINKING AND RESINKING OF HAND TUBEWELLS

1. INTRODUCTION:

The term sinking means, boring a new tubewell and resinking means withdrawing a derelict tubewell and sinking it again with the useful withdrawn materials and with additional new materials. The labour cost of resinking of a well is higher than that of sinking a new well. But overall cost is less than a new well for re-use of the withdrawn serviceable materials and the salvaged value of the unserviceable withdrawn materials.

A hand tubewell consists of generally: (1) Well pipes, (2) Screen, (3) Sand-trap, and (4) Hand pump.

2. FUNCTION & SPECIFICATION OF DIFFERENT PARTS:

2.1. Pipes:

The size of well pipes used for a hand tubewell varies from $1\frac{1}{4}$" to $1\frac{1}{2}$" dia pipes of various materials such as mild steel (M.S.) galvanized iron (G.I.) polyvinyl chloride (PVC) etc. Of these G.I. pipes are universally used for a long time due to its drilling facilities as well as protection against corrosion.

Recently PVC pipes, after pilot projects and research, have become very popular for sinking-hand tubewells for the following qualities:

(a) It is light weight; hence transportation cost is much less.

(b) It is cheaper - at least 40% cheaper than G.I. or steel pipes.

(c) It has got absolute anti-corrosive properties.

(d) Friction losses are low in comparsion with the steel pipes.

(e) Jointing with 'solvent cement' joint is easier and quicker.

For the above reasons many other developing countries have started using PVC pipes in hand tubewells. Presently in Bangladesh PVC pipes are extensively used for sinking hand tubewells.

2.2 Screen:

The screen is the perforated portion of a well through which ground water enters into the well from the aquifer, keeping aquifer sand away from entering into the tubewell.

The following types and sizes of screens are used in Bangladesh:

(a) Brass screens are made out of $1\frac{1}{4}$" to $1\frac{1}{2}$" dia M.S. or G.I.pipes covered with 60 to 80 mesh copper wire net and brass perforated sheets. It is usually made 6' long.

A mesh is a wire net opening. 80 mesh is so called when one square inch of wire net contains 80 square holes or opening and so a 60 mesh is so called when it contains 60 square holes. Hence it is apparent that the opening of a 60 mesh screen is bigger than a 80 mesh screen.

Slotted screen is so called when a pipe is bodily slotted or when slits are made in a pipe. A slot is measured in thousandth part of an inch. Hence 8 slotted screen means an opening of 8/1000 inch and so forth.

The relation between mesh and slot is that 80 mesh is approximately equivalent to 8 slotted and 60 mesh 10 slotted screen.

(b) Other types of screens are also used in hand tubewells such as monolithic brass screen, stainless steel screen, PVC screen, fibre glass screen etc. The stainless steel screen, though superior due to its anti-corrosive property and physical strength to all other screen, is not used for hand tubewells in Bangladesh because of its prohibitive cost. But they are used in big tubewells in urban areas for piped water supply projects.

In Bangladesh fibre glass screens are used only in big diameter tubewells for irrigation use.

The PVC screen being corrosion proof and much cheaper is now extensively used in Bangladesh. 8, 10 and 12 slotted screens are quite suitable for shallow and deep wells in different parts of Bangladesh. Normally 12 feet screen for shallow wells and 18 feet for deep wells are used. Use of only 6 feet screen is an exceptional case where thickness of aquifer is meagre.

2.3 Sand Trap:

A sand trap is an extension of a blank pipe of about 4' to 6' long fixed at the bottom end of the screen. The open end of the blank pipe is sealed with a cap. The purpose of the sand trap is to trap the incoming finer sand which escape from screening out of the screen and settle ultimately in the trap and thus save the screen from blocking.

2.4 Hand Pump:

Hand pump is made of cast iron. The function of hand pump is to pump water from the well by centrifugal force. Presently two sizes of hand pumps i.e. No. 6 and No. 4 are in use in Bangladesh. The yield of hand pump No. 6 is between 6 and 10 gallons per minute. The component parts of a hand pump with their full description can be seen in the DPHE booklet "Facts About a Tube Well". The use of No. 4 hand pump is restricted to the wells whose screen length is 6 feet only.

2.5 Jointing Materials:

G. I. pipes and strainers are joined together with G.I. sockets. The PVC pipes have got two types of joints - (1) PVC socket with threaded joints, (2) Solvent cement joint - normally spigot and faucet ended pipes.

3. TOOLS AND PLANTS:

For sinking and withdrawing a tubewell, the following tools are required:

Chain Tong, Loose Chain, Wrenches, Die, Cutter, Hacksaw and Blades, Swivel, Pulley, Jack, Derrick, Clamps, Force pump, Boring bit, etc.

4. METHOD OF BORING:

Boring of hand tubewells are done in two different methods in Bangladesh.

4.1 Sludger Method:

This is a primitive, but effective method. In this method the well pipe is pushed down into the earth by manual labour with the help of some bamboo staging and rafter. Position of different sand layers in different depth, are obtained correctly in this method.

First of all a pot hole of about 2 ft. dia and 2 ft. deep is made where water is poured. Then a piece of pipe is placed vertically in it and is pushed up and down by jerking action through a bamboo rafter fastened with the pipe. While the pipe is penetrating, the loosened soil enters in and comes out through the top of the pipe making hole into the earth. More pieces of pipes are added while the soil is more and more penetrated.

During the process, the Head Mistry sits on the top of the staging and always takes care that the pipe is driven perfectly vertical.

At every upward and downward motion of the boring pipe, the technical man operates his hand in the mouth of the pipe in such a way that a vacuum is created to give a sucking action.

During the progress of work, soil sample is collected and examined at every 10 to 20 ft. layer. Boring is stopped where good water bearing strata or aquifer is obtained. Then the whole length of pipe is withdrawn piece by piece keeping the bore intact. Immediately after withdrawal sand trap and screens along with pipes are fitted and lowered up to the ascertained depth.

The sludger system is generally adopted for the tubewells whose depth is within 150 ft. The pot hole should always be kept full of water during the period of operation; otherwise caving may occur.

4.2 Water Jet Method:

A powerful force pump is used to pump water into the jetting pipe to loosen the soil and force it out from the top through the annular space between the jetting pipe and the casing.

While boring a tubewell in deep strata, beyond 150 ft., this method is generally adopted. This system is rapid and easy in sinking small tubewells upto any depth.

In water jet method, unlike big diameter wells, full casing is not necessary while boring hand tubewells. Only 20 feet long 6 inch dia. casing pipe from the ground level may do. The rest bore may be made 'open bore' without problem.

5. WITHDRAWING OF TUBEWELLS:

In our country, for withdrawing a hand tubewell the following three methods are generally adopted.

5.1 "Dheky" System:

It is a primitive system, very handy to withdraw a tubewell upto 100 ft. deep. The method is to just applying a lever action to force out the pipes from the ground. The tools required are also simple. A log of tree of 8 to 10 ft. long and a few feet of rope are required for withdrawal operation.

5.2 Lifting by Jack:

This is also simple method but it needs costly equipments. Well of any depth can be withdrawn by this method. In this method 2 Jacks (capacity according to requirement) and one pair of clamps are required.

First, clamps are fixed with well pipe and then the jacks are fitted with the clamps for lifting operation. Care should be taken to operate the jack very smoothly; because if undue force is applied well pipes may be torn at the joints where corrosion is high. When the pipes are too tightly attached to the ground this method alone will not help for withdrawing.

5.3 Side Boring:

In difficult cases, specially where the above two methods fail, a boring should be made by the side of the well to be withdrawn with boring pipes to loosen the soil around the well and then any of the above two methods would be useful for withdrawing. For methods of boring and safe withdrawing of a derelict tubewell detail information may be had from "Facts about a Tubewell", a DPHE Publication.

6. FAILURE OF A TUBEWELL:

Sinking of a tubewell is called a failure if it fails to give potable water or reasonable quantity of potable water by an easy stroke of hand pump.

The following are the probable reasons of failure of a tubewell:

(i) Installation of screen at improper layer i.e. either clay or fine sand.

(ii) Improper development of well.

(iii) If a screen is located in an aquifer where the concentrations of minerals are higher than the allowable limits.

(iv) If the screen is clogged with clay or sand due to breaking during construction of a well or for some other reasons.

(v) Clogging of screen by natural process, due to corrosion, incrustation or sand filling.

The remedial measure for the above causes is to withdraw the well and re-sink it.

A tubewell also fails to give water temporarily due to damages to one or more component parts of the hand pump. The remedy is to replace the damaged parts.

7. DEVELOPMENT OF WELLS:

Development of a well means to pull out fine sand from the aquifer by pumping till sand free water is obtained. This requires to pump out about 50 percent of the aquifer sand around the screen. Development thus makes the aquifer more permeable. Also a development is not done fully after construction of a well, fine sand that comes in during normal pumping of a well is deposited at bottom filling the sand trap and the screen, making the well ultimately choked up within a very short time. Such a well of course can be made good by desanding it — a method which is adopted in maintenance programme.

Currently, wells are generally developed by only continuous pumping till sand free water is obtained. The method of course is not full proof method of development; but under existing conditions this is the only method being adopted in Bangladesh.

8. CONSTRUCTION OF PLATFORM:

Construction of platform is required for:

(i) Keeping the land around the well dry from spilled water for the convenience of the users as well as for aesthetic reason.

(ii) Avoiding percolation of spilled and other polluted surface water at the base of the well.

(iii) To keep the well pipe rigidly fixed.

Platform may be of brick built or cement concrete (C.C.) cast in site or reinforced cement concrete (R.C.C.) slabs fabricated at site. So also a spill water drain, generally 3 to 6 feet long is made to remove spill water away to downward ground slope from the base of the well.

The base of the well, if not on a raised ground should be raised, properly sloped, rammed and consolidated before a platform is constructed.

9. CONCLUSION:

In sinking a well the main point of observation is to maintain depth-quality relationship for economic sinking. Which is, that a well is sunk in a shallower aquifer where water quality is reasonably good. In such aquifer the grain size of the sand should be ascertained by visual observation with the "sand comparator" and slot size of the screen determined. The observation should be recorded for each area. They are:
(1) depth of wells, (2) slot size of screens, (3) water quality(Fe, Cl, hardness etc.) and optimum quantity (gpm).

In this way, the entire area of the country could be surveyed for ground water occurance. The data may be compiled in a book form for use as National data for Groundwater and Wells.

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : URBAN WATER SUPPLY

M. M. Hussain
Deputy Chief Engineer
DPHE, Dacca

MARCH 1975

1. INTRODUCTION:

Man's search for pure water supply began from time immemorial; but thousands of years passed by before our more recent ancestors learnt to build cities and enjoy the convenience of water piped into their houses and drains built to take away the waste water. Ever since it has always been an attempt at improving the standard of convenience and perhaps luxury at the same time reducing health hazards from water to the minimum possible by improving the material, construction, workmanship, quality, aesthetics, etc. But much of the sophisticated water supplies in the world are still the privilege of only a few cities of the world; practically half the urban population of the world are yet to enjoy the benefits of a piped water supply system in their dwellings. We in Bangladesh also form part of the latter group of the world population.

2. IMPORTANCE OF WATER SUPPLY:

Water is next to air from the point of view of its importance as man's survival is very much dependent on the use of water. At the same time, it is also necessary that the water consumed is free from disease causing organism or the presence of any toxic substances which would endanger the health of the consumer. But such needs are becoming increasingly difficult to meet as pollution has reduced the quality of many of the sources of water.

3. REQUIREMENT OF WATER AND PREDICTION OF POPULATION:

Prior to the design of any water supply system, the quantity of water that may be required by the users of a particular area consistent with their habits and possible development over a period of 25 to 30 years has to be worked out. This would mean that the probable growth of population in that period has also to be studied. In respect of prediction of population, the designers often depend on the statistics that may be available with the census and other related organizations. The quantity of water required per head per day is also assumed in comparison with the use of water in towns of comparable nature, also taking into account the prospective growth of industries, etc. in the area.

4. ELEMENTS OF DESIGN:

The essential elements of design of a water supply system of a conventional type are :

a) Quantity of water required
b) Selection of source consistent with quantity and quality requirement
c) System of collection
d) Treatment of water (purification) and hydraulics involved in lifting of water and its storage
e) Disinfection
f) Distribution system and their hydraulics

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5. DIFFERENT USES OF WATER:

The essential uses of water are :

a) Domestic - which includes drinking, cooking, bathing, washing, use by domestic animals, etc.

b) Industrial demand - primarily for manufacturing processes

c) Commercial demand - for hotels, restaurants, public offices, etc.

d) For public utility services - for street washing, gardening, fire fighting, etc.

e) Unavoidable waste.

6. SOURCES OF SUPPLY:

The sources of supply of water in nature are primarily surface water as in rivers, lakes, etc. and from ground water.

7. SYSTEMS OF COLLECTION:

The collection system would include normally intakes and pumping stations in the case of surface waters and infiltration gallaries, collecting wells, tubewells and pumping stations in the case of ground water.

8. TREATMENT/PURIFICATION:

This of course will vary with the quality of water and the extent of purification called for. In respect of surface water, this would involve:

a) Sedimentation which would remove part of the suspended impurities

b) Coagulation, filtration and disinfection (in certain cases additional items like iron removal, softening, etc. may be called for).

In respect of ground water, the treatment may be primarily for removal of iron and manganese or for hardness.

9. DISTRIBUTION SYSTEM:

This will consist of a net work of pipe lines, valves, fire hydrants and reservoirs, etc. There are different systems normally followed in water supplies, namely, the gravity system, the floating reservoir system, and the direct line pumping system.

10. QUALITY CONTROL:

The system of monitoring quality control is an essential item of work to be periodically and systematically done as the quality particularly of a surface water might change from time to time. The impurities normally are

are physical, chemical and bacteriological in nature. There are international standards laid down with regard to the system of analysis to be followed for piped water supplies which form a seperate paper by itself in this training programme.

11. GROUND WATER VS. SURFACE WATER:

Although the conventional system of drawing on surface water, pumping and supplying through a net work of distribution pipe line is the most common practice in a good majority of cities in the world, thanks to the abundant supply of ground water, Bangladesh prefers to draw on ground water and have the water supply in this country from tubewells in most cases.

Between the surface water supply and ground water supply, there is a lot of advantage for the latter over the former. They are described below :

Surface Water	Ground Water
1) Quality of raw water is often bad and treatment by way of primary and secondary sedimentation, aeration, softening, filtration and chlorination are called for.	1) Quality is of a much greater standard - although in some cases excess of iron is met which can be removed by aeration. Most of the other processes can be dispensed up.
2) Needs larger area of treatment works.	2) Needs much less area. Each well can serve a particular zone and the storage reservoir can be located right near-by.
3) Storage has to be carefully designed and often duplicate lines of pumping & distribution in parallel may have to be laid.	3) This contingency does not arise as each can serve an independent zone.
4) Disinfection with chlorine is a must - with systematic periodic analysis for residual chlorine.	4) Can be avoided and routine check at much greater intervals will be sufficient.
5) Cost of chemicals will be enormous.	5) Will be practically none.
6) Pumping charges to lift to various stages of treatment & to reservoirs will be heavy.	6) Though pumping is involved to lift and store water in reservoirs the energy consumption may be less.
7) Overall cost will be heavy.	7) Will be much less.

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Surface Water	Ground Water
8) Time involved for construction will be long.	8) Much less.
9) Needs detailed investigation and design of an elaborate nature.	9) Much less technical design is involved except for ground water study, selection of strainer and pumps, etc.
10) Construction machinery is not very much required.	10) Drilling machinery will be required.
11) Is applicable to any large city irrespective of size although sometimes the distance to source of supply may be too long.	11) Cannot possibly be used for cities where the population may go beyond some 2.5 millions.

In Bangladesh cities are termed municipal when the population exceeds 5,000. Although in all such cases there may not be a municipality as such, town committees may be in position. On this basis, there are 80 urban towns outside of Dacca and Chittagong.

As for Dacca and Chittagong, major water supply schemes are under construction now through independent autonomous organizations known under the name WASA. Both these are financed by IDA Credit and engage Foreign Consultants for design and execution, supervision, etc. with national engineers controlling the operations. Both these are yet to be completed.

As regards the other towns, there are at present 34 towns with some form of piped water supply in operation. In all these cases the water works that existed in some of them prior to partition of India are still being maintained through though some of them have become overloaded and obsolete.

12. <u>HISTORY:</u>

When Pakistan was seperated from India in 1947, there were some 17 water supplies as noted below :

1. Dacca
2. Narayanganj
3. Chittagong
4. Chandpur
5. Comilla
6. Barisal
7. Mymensingh
8. Rajshahi
9. Khulna.
10. Jessore
11. Faridpur
12. Noakhali
13. Satkhira
14. Rajbari
15. Natore
16. Munshiganj
17. Sylhet

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The supply was of a very much restricted nature and only a very few people were benefited. Even as in 1957, per capita availability of water was only between 2 - 10 gallons.

In 10 years, one new water supply at Pabna was installed which supplied only two gallons per head per day.

A scheme to augment the then existing municipal water supply systems was taken up in 1959 and completed in 1967 at Government cost. The augmentation was through the provision of additional tubewells about 60 in number.

The following 9 important towns were then taken up for improving the water supply under the auspices of Directorate of Public Health Engineering which was developed as a seperate entity already by then.

1. Khulna
2. Pabna
3. Rangpur
4. Rajshahi
5. Mymensingh
6. Narayanganj
7. Faridpur
8. Barisal
9. Comilla

It is interesting to note that while the above 9 schemes were under different stages of completion, another 21 towns were taken up for development, (vide list given below).

1. Cox's Bazar
2. Rangamati
3. Noakhali
4. Chandpur
5. Brahmanbaria
6. Habiganj
7. Sylhet
8. Kishoreganj
9. Jamalpur
10. Tangail
11. Munshiganj
12. Rajbari
13. Madaripur
14. Patuakhali
15. Bagerhat
16. Jessore
17. Kushtia
18. Serajganj
19. Bogra
20. Saidpur
21. Dinajpur

None of the municipal water works mentioned above can be regarded as satisfactory today for various reasons. Some are still incomplete, some do not cover the entire area, most of the supplies are far from adequate, the pressure is very much below the required level, no water supply is continuous and quality control is questionable in many cases.

The major constraints which led to such a situation were : materials, money and man-power.

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13. CURRENT PRACTICE:

The water supplies are investigated, designed and executed by the DPHE and handed over to the municipality for maintenance. In theory, the municipality is to pay 2/3 of the capital cost and meet the annual maintenance charges from the time they take over. Due to want of adequate experience and trained personnel in management, most of the water works are poorly managed. Neither do they give a good service with adequate quantity of safe water under pressure nor do they collect charges even to run the systems. To meet shortage, 6,000 tubewells were done by DPHE in 1974 to supplement the existing water supply facilities in the various towns.

A national sector study was conducted by the IBRD/WHO (PIP) Unit during October '73 and they have recommended setting up an authority to improve water supply in eight selected towns, with a $ 9 million initial credit from the World Bank. The offer is under active consideration of the Government. It is presumed that the offer will be accepted and work taken up in the course of a year or so.

14. PROPOSALS:

The DPHE proposals are :

a) to complete the water supplies in towns already taken up

b) to initiate action and proceed with the works of the remaining towns subject to availability of funds and foreign exchange.

The current Five Year Plan provides also for the following in addition to the towns mentioned earlier under Urban Water Supply other than that in Dacca and Chittagong:

1. Gopalganj
2. Feni
3. Bazitpur
4. Jhenaidah
5. Jhalakati
6. Perojpur
7. Lalmonirhat
8. Muktagacha
9. Netrokona
10. Parbatipur
11. Sherpur
12. Thakurgaon
13. Noagaon
14. Manikganj
15. Magura
16. Narsingdi
17. Nawabganj
18. Nilphamari
19. Bandarban
20. Satkhira
21. Narail
22. Kot Chandpur
23. Meherpur
24. Maulvi Bazar
25. Chuadanga
26. Natore
27. Iswardi
28. Bhola
29. Barguna
30. Jaipurhat
31. Sunamganj
32. Gaibandah
33. Kurigram
34. Rangarh

In all the above urban water supplies the works involved are more or less the same. They are :

a) Investigation - Consisting of projection of population, quantity of water demanded for different area - residential, commercial and industrial.

b) Laying out distribution system with respect to location of wells and reservoirs.

c) Studying ground water potential, exploratory boring, location of sites of wells, selection of slot size and selection of pumps.

d) Supply of powers, construction of pumping structures and installation of pump.

e) Type of distribution of system, metering, etc.

f) Training of staff - field as well as management.

g) Fixing of tariff, installation of meters.

h) Setting up quality control units, handing over system to municipality including staff.

The coverage of urban water supply in respect of population in Bangladesh, presents a grim picture compared to other countries in the South East Asia Region. Bangladesh ranks fifth in a list of seven. While on rural water supply we are very much ahead of the countries in the region, we lack behind in urban supply. With the potential we have by way of source and the offer of assistance from foreign agencies and with all the trained manpower we have it is upto us to catch up and achieve the target set for the UN Development Decade for 1980, namely 60% population coverage.

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TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: REPAIR AND MAINTENANCE OF HANDPUMP TUBEWELLS IN BANGLADESH

Q. Islam
Executive Engineer, DPHE
Barisal-Patuakhali Division

March 1975

REPAIRS AND MAINTENANCE OF HANDPUMP TUBEWELLS BANGLADESH

1. INTRODUCTION:

The Directorate of Public Health Engineering (DPHE) is essentially entrusted with the job of promoting Environmental Sanitation through the supply of safe drinking water in both urban and rural areas. When a water supply scheme is completed it needs operation and maintenance. In the case of urban piped water supply systems, operation and maintenance, after completion of works by the DPHE, are normally entrusted to the Pourashavas. But in the case of rural water supply systems (rural hand tubewells) the operation in effect is carried out by the individual user. The department need only maintain them.

Proper maintenance in fact is vital for any water supply system and particularly so for the rural hand tubewells as the health of about 200 people is dependent on every single hand tubewell and thus the vast majority of population of the country as there are already over 200,000 wells. Hence DPHE has taken up the tank of maintaining them also besides sinking. If DPHE fails to maintain hand tubewells properly, soon the tubewells will be out of order and people will be deprived of safe drinking water and in effect the existence of DPHE will be meaningless. So, the maintenance and repair of rural hand tubewells is a sacred duty of DPHE.

2. MAINTENANCE:

Literally, maintenance means to nurse, to develop, to upkeep, etc. and technically it means to keep an installation in true working condition. In general, the term maintenance of hand tubewells means to keep the pump in good working order, to keep the strainer clean and to keep the platform in good condition.

3. REPAIR:

Repair of a hand tubewell means generally the repair of hand pump. The hand pump consists of many movable parts of various materials assembled together. The hand pump consists of the following parts: (Figure 1) - Barrel, Base, Head Cover, Piston Rod, Plunger, Handle, Bucket, Seat Valve, Valve Weight, Nuts and Bolts, etc.

It is just common sense to understand that the component parts of any machine go out of order due to wear and tear from long use, sometimes due to mishandling and occasionally due to unusual break-down and needs fresh spare parts to bring the machine into commission. In the case of the hand pump of a tubewell, there is no exception to it. But the salient point is, are DPHE wells are brought into commission in quickest time as they would demand?

The most vulnerable parts of a hand pump to wear and tear are the bucket and seat valve, because they are made of either leather or PVC. Other parts being of cast iron or mild steel last longer. A PVC bucket may last between 6 months to one year whereas a leather bucket lasts between 15 days to 3 months. This is our latest finding. Also PVC bucket is much cheaper than leather bucket. Seat valve is made of leather and may last between 6 months to 1 year. DPHE is now using PVC bucket extensively. PVC seat valves have not yet proved successful.

Tools and plant required for repair of a hand pump, as shown in figure 2, are: Uria wrench, Pipe wrench, Sly wrench, Screw driver, Hack-saw blade, Hack-saw frame, Pipe cutter, Chain pipe tong, Die etc. Use of each of the above tools would be demonstrated to you in the field after the class hour.

4. MANAGEMENT OF MAINTENANCE AND REPAIR:

Today DPHE has got 200,000 rural hand tubewells spread over an area of 55,200 sq. miles. Each tubewell needs care and attention of a responsible person who can repair it.

In the management set up, last tier consists of the mechanics who are the directly responsible persons for repairing of wells by going from village to village like a postman. Four mechanics in each Thana have been placed for this. They have been posted in Unions. For supervision and control over the activities of mechanics two Sub-Assistant Engineers and one Assistant Engineer have been posted in the Sub-Division headquarters. This means that these three persons, are to manage and control about 26 mechanics spread anywhere in 876 sq. miles of a Sub-division boundary. This is in addition to their other jobs of execution of rural hand tubewells spread over the same area. If the mechanics do not move and work with dedication, it is extremely difficult for Asstt. Engineers and Sub-Assistant Engineers to keep watch over their movements. It requires initiative, intelligence and tact on the part of Assistant Engineers to monitor their movements. The Assistant Engineers can utilize the offices of Union Parishads as information media. The Chairman of each Union Parishad has been given authority to look after the activities of the mechanics. Assistant Engineers should impress upon the Chairman the necessity of their giving authentic reports against the inefficient and defaulting mechanics. For this, the Assistant Engineers should see the Chairman in their places at least once a year. Unless people are taken into confidence and told about our purpose, the maintenance programme would be a failure.

It should be remembered that for every well that is out of order, about 200 people will suffer for want of safe drinking water. And if an epidemic of diseases like, Cholera, Typhoid or Dysentery breaks out, lots of people fall sick from water-borne diseases and many may die. This human feeling should be imbibed in the minds of Sub-Assistant Engineers, Mechanics, Members of U.P. and all concerned. To do that each Assistant Engineer needs to make up his mind first.

COMPLETE HAND PUMP No. 6

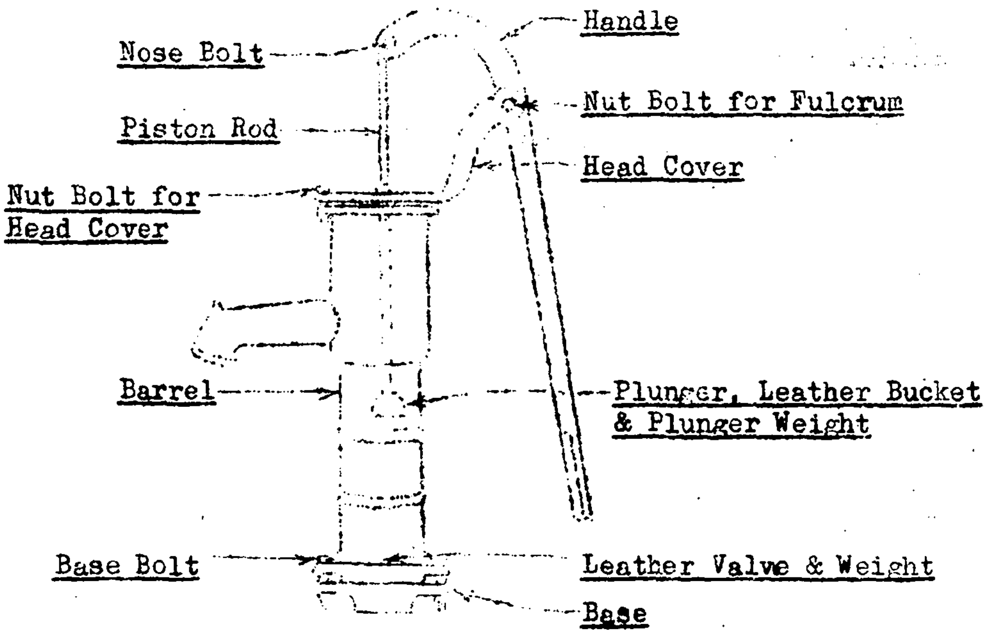

FIGURE - 1

5. INVENTORY:

It requires strict control over the inventory of materials both in stock as well as issued and used by the mechanics. The proof of use of a component part is the production of a damaged part to be taken back to store stock by the mechanics. If that is not done then what else is the proof of utilization? For this, the Assistant Engineers should make random check in the field with the copies of the previous month's progress reports of mechanics.

6. CONSTRAINTS:

The mechanics have got no permanent address or a place of residence in the Union where they can be hauled up.

If DPHE had Thana offices with stores under some supervising staff, service and inspection could be quicker and thorough.

However, till such a position is reached the DPHE Engineers will have to work much harder and make up for the constraints.

7. CONCLUSION:

The ultimate goal of the DPHE is to eradicate water-borne diseases and thus improve environmental sanitation of the entire country. This is really a humanitarian job and hard too, because it is difficult to induce people to adopt health habits and even if attempted it will take a long time. The best way is, therefore, to give health education to school children. They may also be taught about the simple mechanism of a hand pump and how to repair it. Then they will find interest at least to check if the mechanics have actually repaired wells. Also they can diagnose the defect and inform the authority through suitable information media.

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

COURSE CONTENTS FOR MECHANICS TRAINING

SUBJECT : " COURSE CONTENTS FOR MECHANICS' TRAINING "

M. Akhter
Ground Water Engineer
UNICEF, Dacca.

MARCH 1975

TIME SCHEDULE & COURSE OUTLINE

Monday

9.00 AM - 10:00 AM

Class Room Lecture : (Assistant Engineer)

Duties and responsibilities of tubewell mechanics. Present system of maintenance Programme. UNICEF-DPHE programmes of sinking and resinking tubewells. (See Annexure - A)

10:30 AM - 12:30 PM

Demonstration : (Sub-Assistant Engineer)

Demonstration of new pump and spares; PVC buckets; Deep set pumps (where applicable).

Some routine repair and maintenance works.

2.30 PM - 4:30 PM

Class Room Lecture : (Assistant Engineer)

Basic information on sinking and resinking of tubewells. Selection of aquifer.

Selection of slot size. Use of sand comparators. Development of tubewells.

Platform construction, water quality, field tests. (See Annexure - B)

Tuesday

9:00 AM - 5:00 PM

Field Work : (Assistant Engineer & Sub-Assistant Engineer)

Sinking of a tubewell by sludger method; Installation with PVC solvent cement pipe. Tubewell Development.

Wednesday

9:00 AM - 10:00 AM

Class Room Lecture : (Assistant Engineer)

Specification DPHE-007; Clarification clause by clause; Maintenance of records; List of tubewells; Progress Report. Cooperation with local people.

10:30 AM - 12:30 PM

Field Work : (Assistant Engineer & Sub-Assistant Engineer)

Demonstration of Platform Construction.

2:30 PM - 3:00 PM

Written Test

3:30 PM - 5:00 PM

Practical Test.

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INSTRUCTIONS FOR CONDUCTING TRAINING PROGRAMMES

1. All the trainees must attend the classes in time. The trainees who fail to report on the first day at scheduled time must be sent back and this should be reported to the Executive Engineer.

2. Attendance of all the trainees must be checked in every class. None should be allowed to miss, or leave any class unless he is sick.

3. Disciplinary action should be taken against those who are irregular in attending class or are otherwise causing trouble. Action may include debarring from receiving the training allowance.

4. For the lecture on sinking and resinking tubewells, the booklet "Facts about Tubewells" may generally be followed. However, this should be supplemented by recent developments in the use of new materials and other information. One copy of the booklet (Bengali version) should be made available to each trainee.

5. In the sinking of demonstration tubewell, the mechanics themselves will do all the work. They should be taught how to select the proper aquifer by visual observation of the sand samples using "sand comparators". Importance of development of tubewells should also be explained. Site for the demonstration tubewell should be selected near the PHE office where there is need for a tubewell.

6. Copies of Specification 007 (Bengali translation) should be made available to the trainees. All the relevant clauses should be explained to the mechanics. Special attention should be given to the items on tubewell construction and development and platform construction.

7. The trainees themselves will construct the platform under the guidance of the Assistant Engineer and Sub-Assistant Engineer/Overseer.

8. In repair and maintenance demonstration, the trainees should be asked to dismantle the entire pump and then reassemble it. They should also be asked to do some common repair works.

9. In all the classes, the trainees should be encouraged to take part in the discussions and bring out the problems, difficulties and their observations about the work.

10. The written test should be objective type where negative marks will be given for wrong answers. The total mark for written test will be 100.

    The practical test will include identification of tools, spares and implements and some repair works within a specified time. Total marks will be 50.

    After test the Assistant Engineers will examine the paper and prepare a marksheet which should be sent to the Executive Engineer.

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ANNEXURE - A

1. Duties and Responsibilities of Tubewell Mechanics

Tubewell mechanics employed by the Directorate of Public Health Engineering are responsible for repair and maintenance of all DPHE tubewells in the rural areas of Bangladesh. They are attached to the offices of the Assistant Engineers in the sub-divisions but they stay in the field most of the time repairing tubewells in the villages. They come to the sub-division office at the beginning of every fortnight to collect spare parts and submit progress report. They work under the supervision of the Sub-Assistant Engineers and the Assistant Engineers.

The job of a mechanic is of great importance for the wellbeing of the common people. Hand tubewells are the only safe source of water in the rural areas of Bangladesh. The success of the rural water supply programme depends to a great extent on the performance of the tubewell mechanics. Again, the standard of health of the rural population is vitally linked with the success of the rural water supply programme. Thus, the significance and importance of the role of mechanics in the rural society cannot be overemphasized. The mechanics have great official and moral responsibilities towards the society and a lot of dedication and hardwork are necessary to fulfil these responsibilities. Now, the question is, "are the mechanics doing their job properly?" The answer, in majority cases, is "no". There are still frequent complaints about tubewells being lying out of order for months. The impact of a tubewell lying out of order, although not always clearly understood, is rather serious. A broken down tubewell would deprive about 150 people from a safe source of water causing health hazards to all of them. And definitely, in most of the cases the reluctance or negligence of the mechanics is to be blamed for this situation. Now the question is whether the mechanics have any valid reason for not being hardworking or sincere. The answer again is a definite "no". The mechanics are reasonably well paid compared to others in the society and they have some privileges like opportunity of staying in their own homes, having a bicycle etc. which most of government employees do not have. As a matter of fact, DPHE is spending more money on every tubewell than a private owner and still the DPHE tubewells are not working all the time. Thus, the mechanics can hardly justify any claim for additional facilities which they often demand as a condition for better work. The country can hardly afford to spend anything more than what is being spent now. On the other hand, the mechanics should realize or be made to realize that they have no right to stay unless they do their duty properly. The sooner they get the message, the better would be effect on society.

2. Present System of Maintenance

Under the present system, four mechanics are posted in each thana. They are attached to the office of the Assistant Engineer and work directly under the Sub-Assistant Engineers and the Assistant Engineers. As the head of the office, the Assistant Engineer is the controlling officer of the mechanics and he can suspend a mechanic for negligence of duties.

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On an average, there are about 600 DPHE tubewells in every thana. Thus a mechanic has to look after about 150 tubewells spread over 2 to 4 Union Parishads. If a mechanic inspects about 10 tubewells a day, he should be able to inspect all tubewells under his jurisdiction within 15 working days. In few extreme cases, this rate may not be achieved but in most cases, this stated rate can easily be exceeded. Thus, the complains that the mechanics are overburdened can hardly be justified.

To improve the system of maintenance, the Government has empowered the Chairmen of the Union Parishads to check the works of mechanics and the use of spare parts. Unless they certify about the satisfactory work of the mechanics, the Assistant Engineer is not entitled to pay salary to the mechanics. Although this gives rise to sort of dual administration, this will definitely improve the situation provided the U.P. Chairman take positive interest in the matter.

The Assistant Engineer and even the Sub-Assistant Engineers can make the mechanics do better work by proper guidance, physically verifying the progress reports by taking disciplinary action if and when necessary.

3. UNICEF-DPHE Programme for Sinking and Resinking of Tubewells

With the assistance of United Nations Children's Fund (UNICEF), the Government of Bangladesh has undertaken an ambitious plan of providing a large number of hand tubewells in rural as well as some urban areas of Bangladesh. The basic programme includes

a) Installation of 1175 deep wells and 500 shallow wells in the coastal areas.

b) Provision of spare parts for maintenance of 125,000 existing government tubewells. (Now commitment is completed).

c) Sinking of 100,000 new tubewells and resinking of 60,000 choked up tubewells.

The programme is expected to be completed by the end of 1975. On completion of this programme, UNICEF is expected to support the following new programmes between 1975 and 1978:

a) Sinking of 155,000 new shallow tubewells.

b) Sinking 5,000 new deep tubewells

ANNEXURE - B

1. Basic Information on Sinking and Resinking of Tubewells

The booklet "Facts about Tubewells" may generally be followed in respect of methods of drilling of hand tubewells, tools and equipment necessary for drilling and installation of tubewells etc., withdrawal of choked up tubewells etc. The paper entitled "Sinking and Resinking of Hand Tubewells" written by Mr. Matiar Rahman and used in this course should also be followed.

2. Selection of Aquifer:

Selection of proper aquifer or sand layer will determine the success of the tubewell. The aquifer or sand layer in which the strainer is to be installed must consist of medium or coarse sand and for economy the first available such layer should be selected. It is completely wrong to think that tubewells installed at the deeper coarse layers will yield more and better water than those at shallower coarse/medium sand layers. Coarse or medium sand layers situated at any depth below the groundwater table will produce sufficient quantity of water, if the tubewell is installed and developed properly. However, there may be restrictions due to water quality but in absence of any clear evidence of unacceptable water quality at shallower depth there is no point in going deeper. In rural areas, mistakes have been made in this respect and tubewells have been drilled at unnecessarily deeper layer and often producing inferior quality and/or quantity of water.

Selection of proper aquifer need proper collection and identification of sand samples. Samples may be collected at 10 feet intervals and then each sample be carefully ispected and identified. It is preferable to prepare a field boring log for every tubewell. There is no reason why mechanics cannot be properly trained to do this. After identifying each sample and, if possible preparing the boring log, the proper depth can easily be ascertained and length of blank pipe required can be determined.

3. Selection of Slot Size: Use of Sand Comparators

The slot size in the strainer is related to the sand size around the strainer. The slot opening should be such as the strainer will retain only 40% of the sand remaining 60% will pass through the strainer. For easy and quick identification of sand sizes in the field, UNICEF has prepared "sand comparators" which will be distributed among all the technical personnel of DPHE including mechanics. The comparator is a plastic tube having three compartments in which three different sizes of sand samples are shown. The sand sample with marking "8" indicates the size of sand in which No. 8 slot strainer can be used. This also means 40% of this is coarse than 008-inch and 60% is finer. Thus, in sands with markings "10" and "12", strainers with No. 10 and No. 12 slots respectively may be used.

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4. Development of Tubewells

This has been discussed in sufficient details in the paper "Sinking and Resinking of Tubewells" by Mr. Matiar Rahman.

5. Platform Construction

Platform construction is very important specially in case of tubewells with PVC pipes where failure of a platform may very well mean the loss of tubewell. Good platform construction will require the following:

a) Use of adequate quantity of cement (1 bag)

b) Use of good quality khoa and sand

c) Proper mixing of ingredients

d) Proper curing

e) Strictly following the drawing and specification.

6. Water Quality and Field Tests

In drinking water from tubewells, quality is as important as quantity. If the tubewell water is not of acceptable quality due to presence of some undesirable chemicals, people may not use this water and may switch to other unsafe source of water. In Bangladesh, iron and chloride are the two problem chemicals which are frequently present in excess of the acceptable limits. Unfortunately, this aspect has been overlooked in many cases and we still find a large number of tubewells producing water with excessive amount of iron and chloride.

The concentration of iron and chloride can easily and conveniently be measured in the field with help of field test kits. The mechanics can easily be trained in the use of these kits. This will help the strict implementation of specification in respect of water quality.

MA/psb
15.3.75

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TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT : ORGANIZATION AND FUNDING OF MECHANICS' TRAINING

M. Akhter
Ground Water Enginer
UNICEF, Dacca

MARCH 1975

TRAINING OF TUBEWELL MECHANICS

General

The training programme for tubewell mechanics is considered a part of over-all programme for training of the technical personnel of DPHE. Mechanics are primarily responsible for the maintenance of the tubewells, but they are also involved in the supervision of sinking and resinking of tubewells. Hence it is important that the mechanics should have some basic knowledge and information on sinking, resinking and repair of tubewells.

Duration and Time-Schedule

The programme should be of 3 day-duration starting preferably on a Monday. The exact date for different sub-divisions will be decided later on as per Chief Engineer's directives. A tentative time-schedule and course outline have been prepared.

General Arrangements

The training will be held in the Sub-divisional headquarters. The Assistant Engineer will be entirely responsible for the organisation and management of the training. All the mechanics posted in any particular sub-division must attend the training to be arranged in that sub-division. Failure of any mechanic to attend the training will make him liable to disciplinary action and must be reported to the Chief Engineer through proper channel. The mechanics should be informed about the training at least 2 weeks earlier.

The class room lecture may be arranged in any school or any other educational institution located in any central place. The A.E. will make all necessary arrangements well ahead of time. The Assistant Engineer & the Sub-Assistant Engineer/Overseer will conduct the class room lectures and field demonstration as per pre-determined time schedule. The mechanics may be given a copy of the time schedule (Bengali) at the beginning of the programme.

Expenses

The cost for training will include

1) Allowances for the mechanics

A training allowance of Tk 60/- per mechanic will be given on the last day of the training. This will be in addition to usual travelling and daily allowances the mechanics are entitled to receive.

2) Sinking of Demonstration Tubewell

The mechanics themselves will take part in the entire process of drilling and installation of the tubewell; hence there will be no labour cost involved. However upto Tk. 100/- may be spent for bamboo, rope etc.

3) Construction of Demonstration Platform:

The mechanics should themselves construct the platform under the guidance of the A.E. and SAE/Overseer. An amount of Tk. 75/- may be spent for purchasing khoa, sand etc.

4) Stationery:

Each mechanic may be provided with a pencil and few sheets of paper. It may also be necessary to purchase chalk, duster etc. An amount of Tk.200/- may be necessary for these.

The Assistant Engineers will prepare a consolidated estimate covering all these items and submit to the Executive Engineer for prior approval. A typical estimate would as follows (based on 32 mechanics).

E S T I M A T E

1.	Training allowance for mechanics @ Tk. 60/- mechanic	= 60 x 32 =	1,920/-
2.	Purchase of Bamboo etc. for sinking tubewell	=	100/-
3.	Purchase of khoa etc. for platform	=	75/-
4.	Stationery	=	200/-
		TOTAL =	2,295/-

5. UNICEF contribution : On notification by the E.E to UNICEF water section Dacca that all arrangements have been made for a mechanics training course in a particular sub-division, UNICEF will write agreeing to pay the above costs upto a maximum of Tk. 3,000 per sub-division. Payment will be made through the appropriate UNICEF District Representative to the A.E or direct to the mechanics as most convenient.

MA/PQ

TRAINING PROGRAMME

FOR

ASSISTANT ENGINEERS

OF

DIRECTORATE OF PUBLIC HEALTH ENGINEERING

GOVERNMENT OF BANGLADESH

SUBJECT: HEALTH EDUCATION IN THE VILLAGE WATER SUPPLY AND SANITATION PROGRAMME

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Lecturer, Health Education
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Dacca

March, 1975

HEALTH EDUCATION IN THE VILLAGE WATER SUPPLY AND SANITATION PROGRAMME

In the rural areas of Bangladesh, the most important public health problem is one concerned with wholesome drinking water and a safe system of excreta disposal. More than half of the sickness in the country, are attributed to enteric diseases primarily caused by faecal pollution. We have the solution to this in a simple handpump tubewell water supply (good water is fortunately available in plenty in the country) and a sanitary latrine for every home. We have a massive scheme in operation for the former and a proposal for introducing the latter in selected areas as a pointer for better health.

The desired benefits of this scheme, however, depend largely on the public as unless the water supply is utilized properly and in a hygienic manner and the latrines are also used by one and all, the cherished objectives of public health are not achieved and large sums of money spent will be just a waste.

Health education needs are, therefore, perhaps, the most important in a situation of this kind. This would mean bringing about a change in the people from their traditional habits of taking to the nearest source of water or defecating in the open. These changes cannot be achieved easily or quickly. Changes can be brought about only with conscious sustained efforts in educating, encouraging and motivating the people gradually and with consistant effort.

People do not change their habits unless they understand the need for such a change. This would mean enlisting the participation of the people in all the programme, to help in planning and installation and in making them utilize the facilities. Health education thus becomes a continuous process at changing the habits of the people in all spheres - cultural, social and economic. It is not just passing on an information. The field engineers and other staff while in contact with the villagers should create an inter-personal relationship and through such relationship pass on the information required for better living, gradually and methodically.

The health education staff who are specialists in the science should support the activities in the field by training the field workers engaged in water supply and sanitation to:

1) create an awareness in the families about need for safe disposal of excreta,

2) the necessity to use protected water supply,

3) follow hygienic habits at all stages,

4) make every member of the family including the old and the young to practice good habits and,

5) help the family to take a decision to use only good water all the time and also to see that a sanitary latrine is provided and used.

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Health Educators can impart this training by showing the workers how to carry out group discussions, how to elicit support from local people, etc. They can also show how by constant association with the villagers, leaders could be selected and useful village committees formed who in turn would shoulder major responsibilities of popularising the programme and also make the people utilize the amenities extended to them. It is also necessary for the health educators from time to time to evaluate whether in their imparting training to the workers, they have achieved the desired results and if not, how to improve them. They should help the workers to enlist the cooperation and involvement of local teachers, voluntary workers, voluntary organizations, etc. to work with them to make the programme successful.

In respect of tubewell water supply, the field workers must be in a position to meet as many of the potential users of the wells as possible and explain to them the difference between the existing sources of water and the tubewell water, how they can keep the wells in good condition, what they have to do in case of a failure, how to prime a pump, what to do after floods in case of submerged wells, advantage of using bleaching powder, the necessity to keep the platform around the well clean, etc. etc. Similarly in the case of sanitary latrine, the field workers should be trained to talk to the potential users on the clean habits they have to follow in respect of the use of latrines, in flushing, in keeping the approach clean, in making everyone of the family use the latrine, the hazards of open defecation, etc. etc.

The educational methodology to be used may include techniques of working with individual villagers, group discussions and usual contacts, demonstration, village meetings, orientation for school teachers, use of audio-visual aids and periodic evaluation.

It must be said in this connection that before we attempt an educational programme we must understand the community first and this means the health educators and field workers must visit the villages as frequently as possible; and not only that, every visit must include demonstrations and talks in the villages for a sufficiently long time. Such contacts alone will help them to select the leaders. Some of the leaders may be informal in nature, and cannot be located easily. Once the proper leaders are selected, the problem becomes simple. It is then, only a two step flow of communication. Any message given will be taken up by the leader and transmitted to the villagers without any difficulty. Action taken before educating the people, will be more a waste of funds. Again we must patiently listen to the people, be sympathetic and thus stimulate their interest in the programme to ultimately identify with them. Obviously for these qualities to be developed the workers must have an essential sense of duty and discipline in them.

AMFR/psb
15.3.75

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LIST OF TRAINEES

1.	Mr. Mustaq Ahmed	Dacca Sadar (North)
2.	" Joynal Abedin	" " (South)
3.	" Quddusur Rahman	Narayanganj
4.	" Hafizur Rahman Khan	Manikganj
5.	" Salehuddin Ahmed	Tangail
6.	" Qutubuddin Ahmed	Faridpur Sadar
7.	" Abul Kalam	Rajbari
8.	" Md. Yakub Ali	Gopalganj
9.	" Ishaque Ali	Gopalganj (on transfer)
10.	" Mursheduddin Chowdhury	Mymensingh Sadar (North)
11.	" Sk.Md. Khorshed Ali	" " (South)
12.	" Md. Shah Jahan Mallick	Kishoreganj
13.	" Kayemuddin	Netrokona
14.	" Ayub Ali	Jamalpur
15.	" Bazlur Rahman	Barisal Sadar (North)
16.	" A.K.M.A. Sattar	" " (South)
17.	" Golam Sharfuddin	Jhalakati.(from Satkhira)
18.	" Naseruddin Khondker	Perojpur
19.	" Nurul Alam	Patuakhali
20.	" Tofail Ahmed Chowdhury	Bhola
21.	" Shamsul Huda	Burgona
22.	" A.K.M. Ahsanul Hoque	Narail
23.	" Matiur Rahman	Jessore Sadar
24.	" Haripada Sarker	Jhenaidah
25.	" Saifuddin Ahmed	Rajshahi Sadar
26.	" Afzal Hossain	Nawabganj
27	" Abdul Bari	Naogaon
28.	" Md. Shamsuzzoha	Serajganj
29.	" Nazrul Islam	Bogra
30.	" Abdul Huq Sarder	Nilphamari
31.	" Abdur Razzaque	Kurigram
32.	" Abdur Rahman	Gaibandah

33.	Mr.	Mir Aftab Hossain	Dinajpur Sadar
34.	"	Kazi Khawja Baksh	Thakurgaon
35.	"	Khalilur Rahman	Comilla Sadar (North)
36.	"	Khorshed Alam	" " (South)
37.	"	A.K.Md. Yahea	Chandpur
38.	"	Abdul Karim	Noakhali Sadar
39.	"	Abdur Rahman	Sunamganj
40.	"	Abdul Kader Chowdhury	Sylhet Sadar
41.	"	Golam Sarwar	Habiganj
42.	"	Arshadullah	Moulvi Bazar
43.	"	Nurul Hoque	Cox's Bazar
44.	"	Nurul Islam	Chittagong Sadar (North)
45.	"	K. N. Das	Magura
46.	"	Afiluddin Ahmed	Kushtia Sadar
47.	"	Md. Manjurul Islam	Meherpur
48.	"	Md. Yusuf Ali	Khulna Sadar.