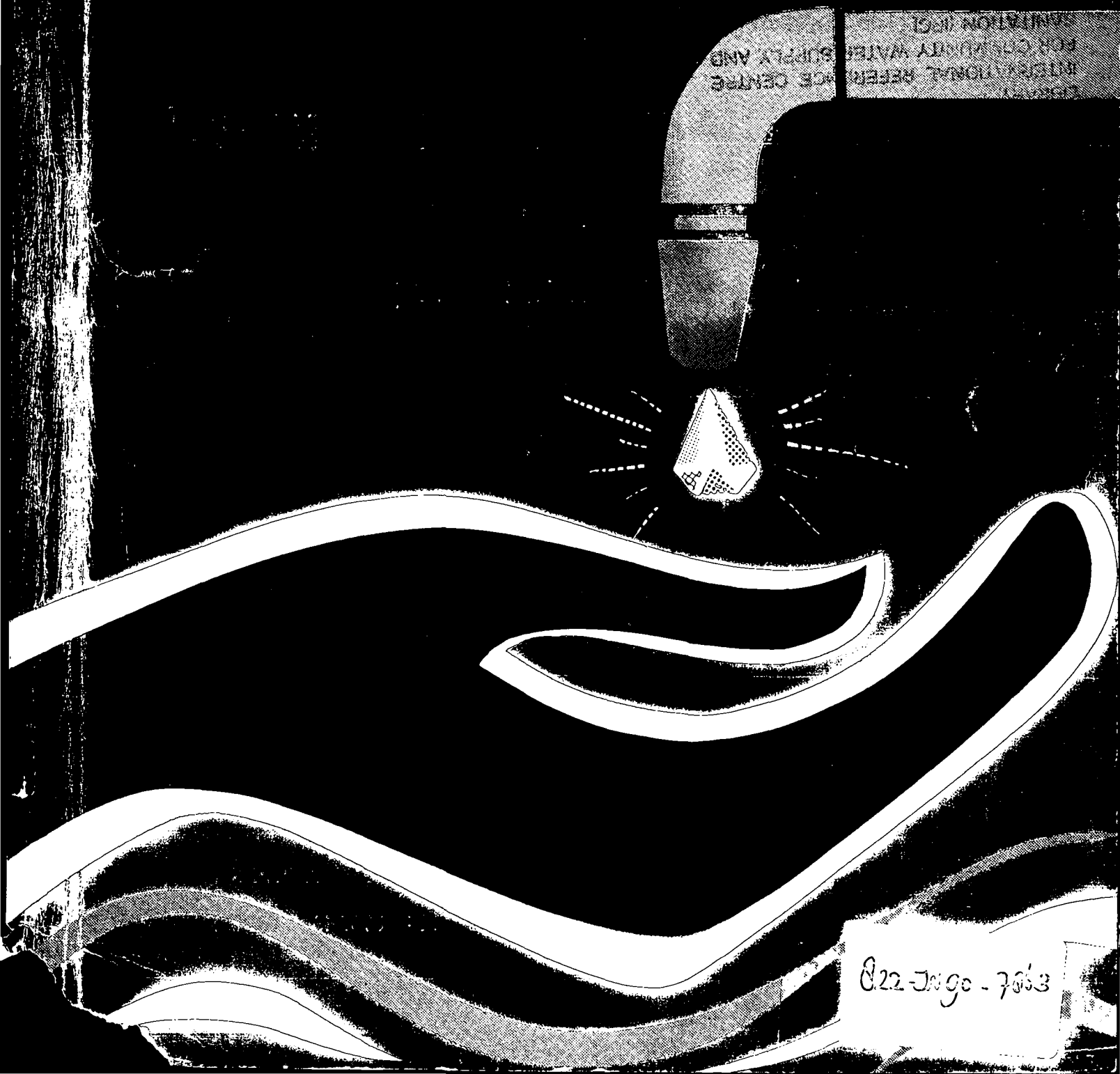
ALL INDIA SEMINAR ON FINANCING AND MANAGEMENT OF WATER SUPPLY SCHEMES 1990



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ALL INDIA SEMINAR

ON

FINANCING AND MANAGEMENT

OF

WATER SUPPLY SCHEMES 1990

THIRUVANANTHAPURAM

SOUVENIR

FOREWORD

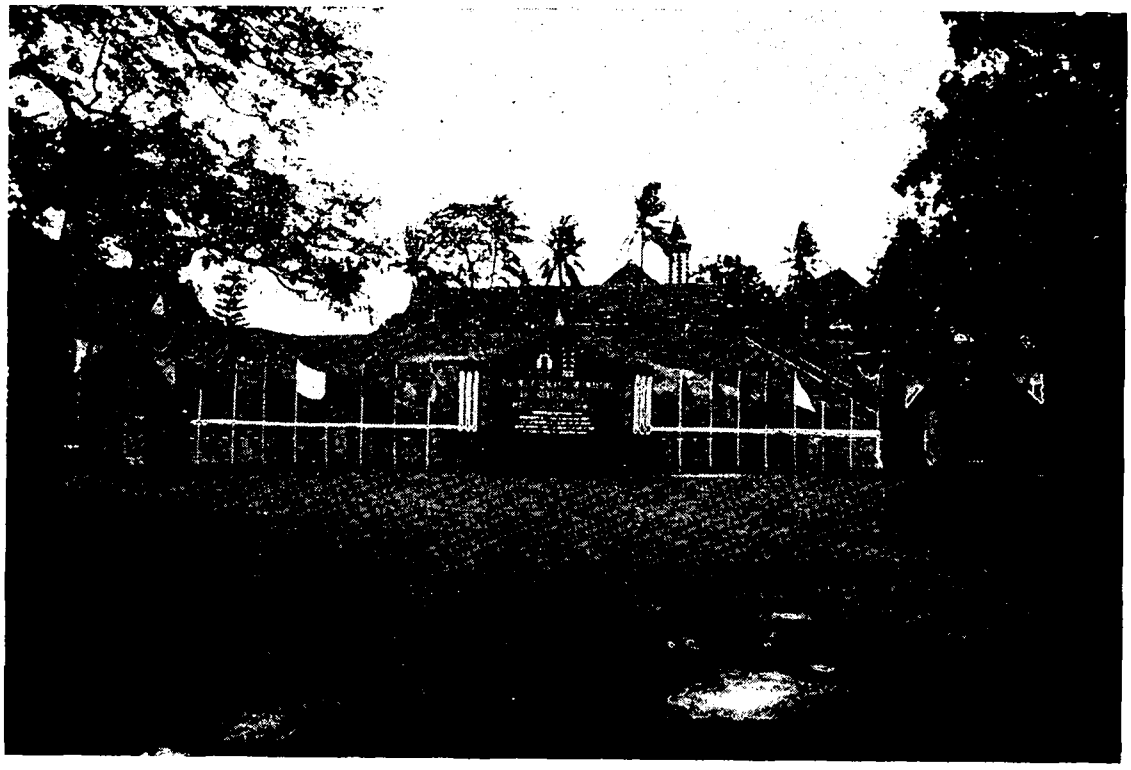
For facilitating interaction between the nation's policy makers, financial experts, administrators and above all the public health engineers who have a special bias towards carrying forward the nation to attain the gigantic task of supplying drinking water to each one of its citizens, the All India Seminar on Financing and Management of Water Supply Schemes, 1990, has been a vital platform This Seminar has provided an opportunity to all concerned to ponder over the past activities, achievements and then formulate proposals visualising their future planning and programmes. Various topics chosen for presentation at the Seminar have been with this end in view. This souvenir contains apart from those papers presented at the Seminar a few more papers which could not be presented there for want of time.

This souvenir is brought out as a special issue to commemmorate the Seminar, which is the second of its kind hosted by the Association of Public Health Engineers, Kerala, in consortium with the Kerala Water Authority and Governments of Kerala and India. The previous Seminar, held in 1973, of similar name dealt with similar topic did yeoman service in furthering the drinking water supply activities at the then prevailing situation. We fervently hope that the present Seminar will achieve still better results.

We sincerely acknowledge the assistance and co-operation received from various agencies (viz.) water Boards/Authorities, Governments–Central and State, and the excellent support received from our wellwishers. We thank the authors for the contribution of their articles brought forth in the souvenir.

We are optimistic that this souvenir will serve as a reference guide for the managers at different levels of heirarchy, who are all engaged in the activities of the water supply profession and allied fields

SOUVENIR COMMITTEE



Entrance to the Kanakakkunnu Palace, venue of the Seminar

Registration in progress

The hon'ble Chief Minister Mr. E. K. Nayanar and the hon'ble Minister for Water Supply & Irrigation Mr. Baby John being received for the inaugural function by Sri. K. Padmanabhan Nair, Managing Director and Sri. M. P. Mohan, Chief Engineer (IPD) of KWA.

The hon'ble Chief Minister inaugurates the Seminar.

ORGANISING COMMITTEE

Patron	:		Sri. BABY JOHN Hon. Minister for Irrigation, and Water Supply Government of Kerala
Chairman	:		Dr. D. BABU PAUL Commissioner & Secretary to Government of Kerala and Chairman, Kerala Water Authority
Vice Chairman	:	1)	Er. K. PADMANABHAN NAIR Managing Director, Kerala Water Authority
		2)	Er. A. S. VARGHESE Superintending Engineer, Kerala Water Authority and President, Association of Public Health Engineers, Kerala
Members	:	1)	Finance Secretary, Government of Kerala
		2)	R & D Secretary Government of Kerala
		3)	Sri. PHILIPOSE THOMAS Local Administration Secretary, Government of Kerala
		4)	Er. K. NAISHADHAN Chief Engineer, PS & GL Kerala Water Authority
		5)	Er. V. VENUGOPALAN Chief Engineer, I.P.D. Kerala Water Authority
		6)	Er. E. A. ABDU Chief Engineer (Southern Region) Kerala Water Authority
		7)	Er. A. K. SADANANDAN Chief Engineer (Northern Region) Kerala Water Authority
		8)	CHAIRMAN Kerala State Pollution Control Board
		9)	Sri. M. GANESAN Finance Manager and Chief Accounts Officer, Kerala Water Authority
		10)	Er. S. KRISHNAVENI Secretary, Kerala Water Authority
		11)	Er. M. SABBAS Managing Director, Kerala Premo Pipe Factory Ltd. Kollam
Chief Co-ordinator	:		Er. R. UNNIKRISHNAN NAIR Technical Member, Kerala Water Authority
Convenor	:		Er. A. JAJU JACOBS Assistant Executive Engineer, Kerala Water Authority and Secretary, Association of Public Health Engineers, Kerala

VARIOUS COMMITTEES CONSTITUTED FOR THE CONDUCT OF THE SEMINAR.

Finance Committee.

Chairman.	E. A. Abdu, Chief Engineer, (Southern Region) Kerala Water Authority, Trivandrum.
Vice-Chairman.	G. H. Yacoob Sait, Superintending Engineer, P. H. Circle, Kerala Water Authority, Kottayam.
Convener.	M. Ganesan, F.M.& C.A.O., Kerala Water Authority, Trivandrum.
Treasurer.	P. Chandrika Kumari Devi, Assistant Executive Engineer, Kerala Water Authority, Trivandrum,

2. Technical Committee.

Chairman.	V. Venugopalan, Chief Engineer, I. P.D., Kerala Water Authority, Kochi.
Vice-Chairman.	Babu J. Punnooran, Deputy Chief Engineer, I. P. D., Kerala Water Authority, Kochi.
Convener.	K. G. Govindankutty Nair, Executive Engineer, I. P. D., Chief Engineer's Office, Kerala Water Authority, Kochi.

3. Reception, Accommodation & Transport Committee.

Chairman.	K. Naishadhan, Chief Engineer (PS & GL), Kerala Water Authority, Trivandrum.
Vice-Chairman.	S. Krishnaveni, Secretary, Kerala Water Authority, Trivandrum.
Convener.	R. Ramanujam, Executive Engineer, P. H. Division, Kerala Water Authority, Trivandrum.

4. Catering Committee.

Chairman.	A. S. Varghese, Superintending Engineer, P. H. Circle, Kerala Water Authority, Quilon.
Vice-Chairman.	M. Sabbas, Managing Director, Kerala Premo Pipe Factory, Puthenthura P. O., Quilon.
Convener.	C. N. Sasidharan, Assistant Executive Engineer, P. H. Sub Division, Kerala Water Authority, Chavara, Quilon.

5. Entertainment & Publicity Committee.

Chairman.	M. P. Mohan, Chief Engineer (On leave) Kerala Water Authority.
Vice-Chairman.	R. V. A. Thampuran, Superintending, Engineer, P. H. Circle, Kerala Water Authority, Cannanore.
Convener.	P. K. Sahadevan, Executive Engineer, Water Supply Division, Kerala Water Authority, Trivandrum.

6. Volunteer, Technical Site Visit & Sight Seeing Committee.

Chairman.	A. K. Sadanandan, Chief Engineer, (Northern Region), Kerala Water Authority, Kozhikode.
Vice-Chairman.	Abdul Wahab, Superintending Engineer, P. H. Circle, Kerala Water Authority, Kozhikode.
Convener.	K. G. Ravi, Executive Engineer, World Bank Project Division, Kerala Water Authority, Trivandrum.

7. Hall Arrangement & Exhibition Committee.

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Vice-Chairman.	N. S. Renjanan, Superintending Engineer, P. H. Circle, Kerala Water Authority, Trichur.
Convener.	K. Vijayakumaran Nair, Executive Engineer, Drainage Division, Kerala Water Authority, Trivandrum.

8. Programme Committee.

Chairman.	P. Subramonian, Deputy Chief Engineer, Kerala Water Authority, Trivandrum.
Vice-Chairman.	K. M Ninan Tharakan, Deputy Chief Engineer, Kerala Water Authority, Trivandrum.
Convener.	G. Kesava Iyer, Executive Engineer, Kerala Water Authority, Trivandrum.

9. SOUVENIR COMMITTEE

CHAIRMAN	VICE-CHAIRMAN	CONVENER
P. Ramachandran Nair Superintending Engineer P. H. Circle Kerala Water Authority Trivandrum.	K. Padmanabhan Achari Executive Engineer Kerala Water Authority Trivandrum.	K. P. Krishna kumar Asst. Executive Engineer P. H. Sub Division Kerala Water Authority Neyyattinkara.

MEMBERS

B F H R Bijli Executive Engnieer	K. Anil kumar Asst. Executive Engineer	K. Alagappan Asst. Executive Engineer
A. Arunachalam Executive Engineer	M. David Asst. Engineer	G. Sudev Asst. Engineer
George G. Mathew Asst. Engineer	T. A. Sarabindu Rani Asst. Engineer	K. Vasantha Asst. Engineer
S. Harihara subramoni Asst. Engineer	M. Suresh Asst. Engineer	Jyothi Prakash Asst. Engineer
	Leena G. Nair Engineer Trainee,	

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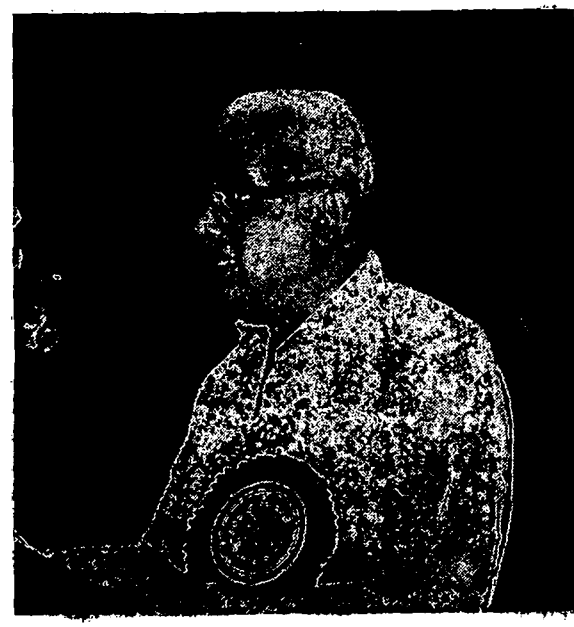
INAUGURAL ADDRESS

By

Shri. E. K. NAYANAR
HON' BLE CHIEF MINISTER, KERALA



Dear Shri Baby John and distinguished guests,

It gives me immense pleasure to be in the midst of you all to participate in the inaugural function of the All India Seminar on Financing and Management of Water Supply Schemes, held under the auspices of the Ministry of Urban Development, Government of India, Kerala Water Authority and the Association of Public Health Engineers, Kerala. I understand that this seminar is being attended by officials from the Government of India, Public Health Engineers, Administrators and financial experts from the various states as well as research organisations besides representatives from The World Bank, Netherlands Government, DANIDA, financial institutions such as L. I. C. of India, HUDCO and manufacturers of various items pertaining to water supply and sewerage system. I take this opportunity to express my thanks to the organisers of the seminar for having invited me to inaugurate the seminar.

Provision of protected water supply is of paramount importance and has been receiving the attention of all developed as well as developing countries. The water supply and sanitation programme has received a boost during the International Drinking Water Supply and Sanitation Decade. As you all know, under the International Drinking Water Supply and Sanitation Decade, it was originally proposed to achieve 100% coverage for drinking water for all the Urban and Rural population by the end of the Decade. As regards sanitation, it was proposed to provide either sewerage or sanitation facilities for 80% of the urban population and sanitation facilities for 25% of the rural population. The targets set were rather ambitious and a review conducted recently has revealed that there is considerable short fall in the achievements against the targets.

Out of the 216 class I cities in the country, many of them do not even have the minimum per capita supply. At the beginning of the International Drinking Water Supply and Sanitation Decade, about 72% of the urban population in the country had water supply facilities and 25% had sanitation facilities. At the end of March 1988, the urban water supply coverage has increased to approximately 82 per cent and Sanitation facilities to about 44%. The urban population covered by water supply in the State, during the corresponding period has increased from 59% to 68%. Similarly the urban sanitation coverage in the State has increased from below 10% to 32%. Considerable gap exists between the target and achievement in the rural sector also.

The major factor responsible for the considerable short fall in the achievement during the Decade can be attributed to financial constraints. Though there has been considerable increase in the plan allocations for the water supply and sanitation sector, the allotments were not adequate commensurate with the requirements. Considering all these aspects, the conference of the Secretaries, Chief Engineers and Heads of implementation Agencies of water supply and sanitation held in 1988, recommended 100 per cent population coverage in urban water supply by 1995, keeping in view the progress achieved so far. As regards sewerage or sanitation, it is envisaged that the target would be to cover 75 per cent by 1995 and concerted efforts should be made to reach 100 per cent coverage by the year 2000. An estimated outlay of Rs. 14,000 crores would be required during VIII Plan for achieving the above mentioned targets in respect of urban water supply and sanitation in our country.

The requirement of funds for achieving the decade targets for the urban and rural sector in Kerala is assessed to be of the order of Rs. 1400 crores. It will be difficult for the State Government to provide all the funds required for such massive investments within the next five to ten years. It is gratifying to note that financial institutions like L. I. C. of India, HUDCO etc. have come forward and extended loan facilities for the implementation of these schemes fulfilling their social obligations. Also financial assistance rendered by Bilateral agencies, World Bank, UNICEF and other such agencies actively involved in the field has given some momentum to the programme.

We have thus seen that a wide gap exists between the financial requirements and the actual availability of funds It is for this seminar to discuss and arrive at suitable ways of reducing the gap by suggesting appropriate technologies and other possible approaches to solve the problem.

Also we have to think in terms of raising internal revenue through the introduction of appropriate tariff, improved and efficient system of billing and collection. It is observed that eventhough emphasis is made for implementing new schemes, operation and maintenance aspects do not get adequate attention. As a result, a number of schemes go into disrepair for want of proper maintenance. Utmost importance has to be given for the operation and maintenance of schemes.

I hope that all the aspects relating to the financing and management of water supply schemes will be discussed in great detail and the seminar will come out with concrete suggestions for achieving all round improvement of this vital sector and the participants will be greatly benefited by the deliberations.

With these words, I have great pleasure to inaugurate the conference. □

PRESIDENTIAL ADDRESS

By

Shri. BABY JOHN
HON'BLE MINISTER FOR
IRRIGATION & WATER SUPPLY, KERALA

Dear Chief Minister and distinguished delegates,

I have great Pleasure to be with you to participate in this " All India Seminar on Financing and Management of Water Supply Schemes" sponsored by the Kerala Water Authority and Co-sponsored by the Ministry of Urban Development and the Association of Public Health Engineers, Kerala. I heartily congratulate them for organizing such a seminar on a topic of current significance and on a nation-wide scale. I also thank the organizers for giving me the opportunity to address this august audience consisting of Public Health Engineers, Academicians, Researchers, Administrators and Experts.

Provision of adequate drinking water supply facilities to the people should always be in the list of priorities of any Government of a civilized society. It is heartening to note that both the Central Government and the Governments at the States have been giving increasing importance in tackling the drinking water problems in the successive annual plans. The Accelerated Rural Water Supply Programme initiated by the Government of India has lent a positive support to the States in their programmes for providing drinking water supply to the rural masses. The National Technology Mission, also set up by the Central Governments is helping to evolve technological models for rural water supply which can be replicated in other places with the required modifications. Despite these measures, it is a sad reality that the poor section of the society in the rural sector has not yet secured any significant benefit out of the water supply schemes and that much is left to be desired in this sector. In this connection I would request the Central Government to introduce a scheme for providing water supply in small and medium towns on the pattern of the Accelerated Rural Water Supply Programme, thereby helping the urban poor.

The problems faced in the implementation and operation of the water supply schemes are multifold-financial, technical and managerial. No doubt, our public health engineers will be able to evolve solutions to even the most difficult of technical problems, through their expertise, in the matter of location of suitable sources, putting up structures and treatment units, and distribution of the potable water. However, the technical solutions will become fruitful only if the accompanying financial and managerial problems are also solved. The financial problems arise mostly out of the fact that the resources of the State are always limited and have to be divided among competing demands. We often find that despite the utmost desire of the government to provide for the basic human need of drinking water, the financial requirements far exceed the affordability of the State. Thus while on the one side, the Government is gripped with its social responsibility,on the other side its hands are tied when coming to allocation of resources. In today's world there is anything one can hardly get free of cost. Even the air one breathes, has a cost attached to it by way of indirect charges for pollution abatement measures. Therefore, drinking water should also be

considered as any other economic commodity produced and supplied through the market channels, the only distinction being that the profit motive is not there, since the responsibility is owned by the State Agencies. The cost of production and supply of drinking water can then be realised from the consumers by adopting an appropriate pricing policy which takes into account the prevailing socio-political and economic situation of the states. Under the scheme of cost recovery effected through a system at water tariff structure, it may be possible to approach financial institutions for mobilising the capital requirements of new schemes proposed to be implemented. In this context, it is worth while considering free supply of drinking water to the poorest of the poor. Income generating schemes may, perhaps call for adoption of altogether different design norms from those being followed at present. World Bank, Bilateral Agencies, LIC and HUDCO are the major institutions providing financial assistance for water supply schemes at present. The Nationalised Banks should also come forward for funding water supply schemes in urban as well as rural areas at a nominal rate of interest and fulfil an important social obligation.

I have expressed some of my thoughts on the implementation of new schemes. Equally important is the upkeep of the schemes from the very moment of their commissioning. The technical solutions to the problems aided by the financial solutions may result in a hierarchy of water supply systems, depending upon the rural-urban character of the communities, the raw water sources available, the nature of terrain etc. These may range from simple bore well and hand pump systems to very complex systems involving a variety of engineering structures and sophisticated mechanical, electrical and electronic equipment. Different strategies have to be followed in the upkeep of the water supply systems, depending upon the level of technical skill required. The communities must be involved and they must volunteer themselves to take up the responsibility for the upkeep of the simple systems like the hand pump, leaving the complex systems to be managed by experts.

Let me now highlight another managerial problem. Empirical evidence available, points to a major problem in the water supply systems which needs to be given greater attention in the future. This is the problem of wastage of precious drinking water in the course of distribution. In some cases the wastage of water is estimated to be as high as or even greater than 30 % of the total water produced-a magnitude enough to cause great concern. It should be possible to reduce the losses to the unavoidable minimum through an effective leak detection, which is relevant to avoid water contamination and preventive maintenance programme. This will not only help avoid the loss of revenue, but the precious water saved can be made available to the needy people.

Yet another important problem deserving our attention is, the preservation of the water sources. Many of the sources of drinking water are being affected by heavy pollution from industrial and domestic effluents. The pollution has to be effectively checked and controlled for sustained availability of drinking water. The cost of water treatment will also increase, if pollution is not checked. Over-exploitation of water resources, especially ground water has also to be controlled, for the long term availability of water and for meeting the drinking water needs in times of crises such as droughts.

Of late, an information revolution is taking place in almost every sphere, especially with the advent of microcomputers. We should not feel shy of using the power of these modern gadgets for updating our information base, relating to water supply as availability of correct and up-to-date information is the most powerful modern management tool in the decision making process.

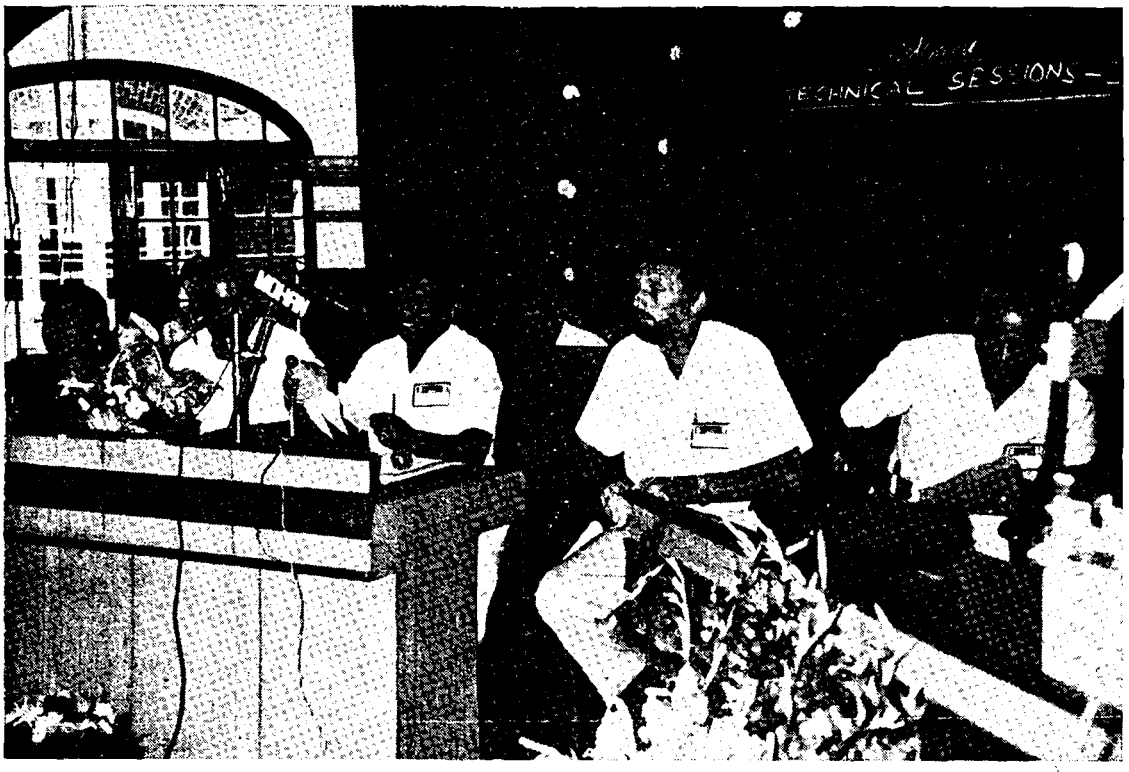
I have shared with you some of my thoughts, but you are the people who are experts in this field. I hope that the deliberations at this seminar during three days, will help evolve concrete suggestions on these and other similar issues relevant to the subject.

I wish the seminar all success. □

TECHNICAL SESSION - I FINANCE

Key note address by Sri. S. Sreenivasan, Chief Engineer (Planning), Madras Metro (President, Indian Water Works Association)

A view of the delegates during one of the technical Sessions.



Technical Session 1 in Progress

'Kathakali'-traditional folk art of Kerala in Progress

LIC's Role in Financing Drinking Water Supply Schemes

B. R. GUPTA
Secretary
LIC of India, Bombay

LIC has been advancing loans to Local Bodies/ State Level Water Supply & Sewerage Boards for financing water supply and sewerage schemes within the amount allocated by the Planning commission for each State every year. The loans for water supply schemes are given for only such schemes which provide water for drinking purposes and not for industrial use or irrigation purposes. These loans are advanced at concessional rate of interest and the present rate of interest is 10.25% for urban schemes with repayment term of 25 years including moratorium period of 3 years and at 10.5% for rural schemes with repayment term of 28 years including moratorium period of 3 years. These loans are advanced on the security of the concerned State Government guarantee. LIC for long has been the only public financial institution in the country which is advancing loans for drinking water supply and for sewerage schemes. LIC's assistance in this sector during the last few years has been of the order of Rs. 70.00 crores to Rs. 80.00 crores per year and the total loans advanced for water supply and sewerage schemes in the country is to the extent of Rs. 896.66 crores upto 31st March, 1989. Recently LIC in consortium with UTI & GIC has also created a fund for financing water supply schemes in cities facing chronic drinking water supply problems. These loans are given over and above the allocations made by the Planning Commission for the concerned State and such loans carry 14% rate of interest with repayment term of 25 years including moratorium period of 3 years. These loans are also given on the security of the State Govt. guarantee. These additional loans are sanctioned subject to availability of funds.

With a view to making the best use of available resources, LIC would like that new water supply schemes to be financed by LIC should as far as possible be taken up in the following priority order.

a) New schemes including extension schemes at places where at present there is no supply of potable water at all.

b) Augmentation schemes where though potable water is being supplied there is acute shortage of water i. e. the per capita supply is less than 20 litres per day.

c) Augmentation schemes where the present per capita supply of water is less than the following quantum:-

For Municipalities with a population	Per Capita Supply
i) Upto 10,000	70 to 90 litres/day.
ii) 10,000 to 50,000	90 to 110 litres/day.
iii) 50,000 to 5 lakhs	110 to 135 litres/day.
iv) 5 lakhs to 10 lakhs	135 to 180 litres/day.
v) 10 lakhs and above	180 to 225 litres/day.

In all cases preference should be given to tourist centres and places of pilgrimage.

With a view to financing large number of schemes in various States and ensuring a certain amount of financial participation by local bodies/ State Governments who are primarily responsible for providing the basic amenities of water supply and sanitation, LIC has evolved the following pattern of financing of schemes.

	LIC's SHARE
i) Schemes upto Rs. 1 crore	2/3rd of the cost
ii) Schemes over Rs. 1 crore	
a) For first Rs. 1 crore of the cost of the scheme	2/3rd of the cost
b) For next Rs. 1 crore of the cost of the scheme	50% of the cost
c) For next Rs. 3 crores of the cost of the scheme	40% of the cost
d) For cost in excess of Rs. 5 crores	25% of excess cost over Rs. 5 crores.

The above pattern is applicable to urban water supply and sewerage schemes. For rural schemes costing less than Rs. one crore, LIC's assistance will be to the extent of 50% of the cost only and for schemes costing more than Rs. one crore, LIC's assistance for first Rs. 1 crore of the cost will be 50% and for the balance cost, the pattern of financing will be as indicated above for urban schemes. The State Governments have to ensure that the balance finance is provided either by the local bodies from their own resources or by the State Government by way of grant or loan.

Normally LIC will finance overrun on account of price escalation to the extent of 25% of the original estimated cost of the schemes. In case of projects costing more than Rs. 5 crores, LIC will not finance any overrun in the estimated cost of such project. It will be the responsibility of the State Government to ensure that entire overrun where project costs over Rs. 5 crores and overrun in excess of 25% where the cost of the scheme is less than Rs. 5 crores is financed either by the local bodies from their own resources or by the State Government.

Each scheme which is posed to LIC for financing has to be administratively approved and technically sanctioned by the State Government, In respect of schemes costing over Rs. 5.00 crores the technical approval by Central Public Health Engineering Environment Organisation (CPHEEO), Ministry of Urban Development, Government of India is necessary. The cost estimates should be prepared on a realistic basis taking into account the cost of material and labour. The estimate should also provide for contingencies. LIC will normally consider such schemes for loan whereunder per capita cost is not more than Rs. 500/-. LIC would not like to finance schemes where the work has already been taken in hand and a portion of expenditure has been incurred on the scheme. However, an exception may be made by LIC in the cases of schemes whereunder a small amount of expenditure has been incurred. In such cases LIC's assistance will not be available in respect of expenses already incurred and loan will be considered for the balance cost after deducting the amount already spent before approaching LIC for loan. LIC would be financing only such schemes which are found also financially viable.

LIC will consider financing water supply schemes which would be financially self supporting on their completion. In other words the income accruing out of the schemes after completion should be sufficient to meet the cost of operation and maintenance, depreciation and payment of interest and repayment of principal on the loans raised for financing the schemes. To ensure financial viability of the schemes it is necessary that the schemes are operated, maintained and managed on scientific lines by introducing appropriate water rates or by revising the existing water rates/taxes suitably and by giving metered connections wherever new connections are given, converting the existing unmetered connections into metered ones and increasing the proportion of saleable water by reducing free supply, leakage, etc.

It has been observed in the past that LIC is informed at the time of approaching for loan that the tariff structure will be suitably revised on completion of the scheme so as to make the scheme financially viable. However, in actual practice, many times the tariff are not revised as proposed and this results in the schemes running into deficits, and as a result thereof defaults are committed by local

bodies/water supply and sewerage boards thereby impairing the flow of funds which hampers LIC's capacity to assist the various socially oriented programmes. It is, therefore, imperative on the part of local bodies/water supply and sewerage board to examine the tariff from time to time and make the necessary revisions as and when needed so as to generate sufficient income to operate and maintain the scheme as well as to service the loan smoothly.

LIC releases the 1st instalment of loan under any new Water Supply Scheme based on the expenditure to be incurred during the financial year in which the scheme is taken up for execution. Subsequent instalments are released after satisfactory financial/physical progress is achieved under the scheme. The progress of the scheme is deemed to be satisfactory if the LIC loan raised in the past together with the matching contribution to be brought in by local body/State Government is fully spent and corresponding physical progress is achieved. The amount of subsequent loan instalment is released on the basis of likely expenditure to be incurred and physical progress to be achieved during the year in which the application for subsequent loan is received. Periodical inspection wherever felt necessary by LIC is also carried out by LIC officials to assess the actual progress achieved before release of subsequent instalments of loan.

It is often noticed that many times the pipes are first procured and the work relating to the development of source, treatment plant, service reservoirs, etc. is taken up at a later stage. It is felt that in order to see that the schemes/projects are completed as early as possible all the relative jobs regarding the execution of the schemes should preferably be taken up simultaneously. Since this is not being done, it is noticed that in majority of the schemes the time schedule for completion of the scheme is not adhered to and there is inordinate delay in completing the schemes. This results in escalation of prices and overrun much beyond the expectation. This should be avoided. The water supply/sewerage schemes where the estimated cost does not exceed Rs. 1 crore should be normally completed within a maximum period of 3 years and schemes costing more than Rs. 1 crore should be completed within a period of 4-5 years at the most.

Though Local bodies are statutorily vested with the responsibility of development of water supply and sewerage facilities but the scale on which the water supply / sewerage facilities are to be provided in urban areas to pose complex organisational and technical problems. A few decades ago water supply for small towns could be organised independently for each town with water resources available within the town area in its visinity. However, as the towns grew into cities larger quantities of water have to be brought from longer distance which may also serve smaller towns and enroute villages and quality of the water provided is to be ensured. It is therefore, necessary that each State should have autonomous water supply/ sewerage boards for proper and rapid development of water supply and sewerage schemes. Such autonomous board with all the technical staff and with financial responsibility will certainly be a better organisation to achieve desired results. Such a board under the charge of technical people with qualified staff in technical, organisational, financial and managerial fields will be better equipped to plan, develop and manage on scientific lines. It will also ensure scientific planning, designing and construction of the scheme with a view to making the best use of scarce resources. Such boards are already existing in the States of Maharashtra, Tamil Nadu, Karnataka, Kerala, U. P., Punjab and Gujarat. It would be advisable that the other States who are not having any autonomous water supply/sewerage board should take initiative in the matter and try to see that such boards are formed in their States. As stated above, the water rates have to be such that the income generated from the scheme is sufficient for not only operating and maintaining of the scheme but will be adequate for paying debt service charges, for providing depreciation and also to earn some surplus fund for future investments. The general experience in India is that the local bodies are reluctant to raise the water charges with a view to making the water supply schemes financially viable. This is perhaps because of the general notion that it is the duty of the local bodies to provide water free to public and as these local bodies are run by elected representatives they are reluctant to increase the water rates to avoid public disfavour. Besides on account of their very nature of organisation these local bodies, except a few large size muncipal corporations, do not have proper accounting and management systems for want of adequate and qualified staff. As a result,

water supply schemes incur deficits year after year and they have to be subsidised either from other revenues of the local bodies or from the State Govt. grants and subventions whereas autonomous water supply/sewerage boards are expected to reorganise the management system and to introduce appropriate water rates on the basis of scientific studies carried out on their behalf with a view to making the scheme financially viable and earn the maximum possible surpluses. These boards can also make an attempt to provide necessary subsidies to the systems in difficult places in the rural areas out of the surpluses earned in the urban areas by way of cross subsidisation. In fact even in urban areas emphasis should be given on the differential and gratuated rates in order to charge water rates as per the paying capacity of different income groups as also the quantum of consumption. The Water rates that should be charged from industrial units can be much higher than that charged for water supply for domestic use. In addition to this there can be special rates for each industrial units which consume water in bulk. The effort should, therefore, be made by the local bodies/water supply and sewerage board to rationalise the pricing system and see that the water meters are practically provided to all the consumers, and that effort should also be made to upgrade the levels of maintenance which in turn will improve the carrying capacity of water mains and reduce the proportion of leakages.

FUNCTIONS OF GOOD MANAGEMENT

Good management of a Water Supply System whether large or small, embraces of functions such as

1. provision and maintenance of adequate facilities.
2. good and smooth operation.
3. provision of a satisfying service to consumer.
4. efficient maintenance.
5. establishment of sound fiscal methods.
6. development of equitable water rates
7. efficient organisational structure and procedures
8. development of technical and financial plans for future expansion.
9. supervision of personnel.
10. control of equipment and supplies.

Broadly speaking the management phase of Water Supply can be divided into two parts: the first part is administration which deals with organisation, records, finances, personnel and supplies and the second part is operation and maintenance which is concerned with the conveyance and delivery of safe water from source to the consumer.

Compiled by B. Bijli

Planning in Financing of Water Supply Projects

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1.0 INTRODUCTION:

The importance of water, vitally concerned with man's well-being, has been appreciated from times immemorial. Its importance as a constituent of environment to be controlled from the point of view of preventive public health has also been appreciated since a few decades ago. Immediately after independence progressively more and more provisions came to be made in the successive five year plans for water supply and sanitation programmes. The incidence of diseases due to lack of safe and adequate water supply, together with poor sanitation is too well known. It is estimated that 80% of the diseases in the world are water borne or water related and 10% of deaths in developing countries are due to these diseases. Water borne or water related diseases which contribute to low life expectancy is also responsible for a poor quality of life. A reasonable level of health is vital and fundamental to economic development. In 1976, the U.N. conference on Human settlements hit on the theme of "Clean water and sanitation for all by 1990". The U.N. water conference held in Mardel Plata, Argentina in March, 1977 declared 1981–90 as the International Drinking Water Supply and Sanitation Decade (IDWSSD) and committed to adopt programmes with realistic standards to provide water for urban and rural areas by 1990.

International Drinking Water Supply and Sanitation Decade - status.

The status of the coverage of urban water supply and sanitation and rural water supply and sanitation at the beginning of the decade, target fixed for the decade, the coverage achieved by 31.3.87 and the sealed down target for the decade are furnished in the following table:

Coverage at beginning of the decade %	Target fixed for the decade %	Sealed down target for the decade %	coverage achieved by 31–3–87. %
Urban water Supply 72.25	100	90	79.24
Urban Sanitation 25.04	80	50	40.37
Rural water Supply. 30.80	100	100	80
Rural Sanitation 0.50	25	20	1

The IDWSS decade is going to end shortly but the target set for providing water supply and sanitation for urban and rural are yet to be achieved. The programmes are to be continued in the next decade also until the goal of clean water and

sanitation for all is achieved. Investment in water supply and sanitation programmes, which contribute to improvement of the health of the community results in, monetary savings by way of gain in man-hours, in health measures, substantial reduction in hospital expenses etc., thereby liberating money for additional investments in economic activities.

2.0 COST OF THE PROJECT

2.1. INSTALLATION COST

Capital cost from an economic and engineering point of view means the amount invested to implement a project from the beginning of it to the times it is put into operation. It includes the purchase of property, payment for the construction of structures, equipment and the engineering services and the interest charges on the loan for implementing the project during the construction period.

2.2. OPERATION AND MAINTENANCE COST

The annual O&M cost includes the salary of the maintenance staff like operators, electricians, cleaners and watchman, the electrical energy-charges to run the pumps and other machineries, the cost of chemicals such as alum, lime, chlorine etc., for water treatment. This cost is proportional to the quantity of water supplied, duration of pumping and level of treatment required, which also varies with the season. This cost is therefore variable and increases with the increase in quantity of water supply. Correct computation of yearwise annual O&M costs is to be made and tabulated.

3.0. BENEFITS OF THE PROJECT

The benefits represent the minimum amounts limited to the returns from the water tariff revenue, possible on account of the willingness to pay by users of water. For more comprehensive analysis, a less restricted evaluation of user benefits, the economic benefits of improved health standards and industrial benefits arising from a more reliable water supply is to be done.

The revenue of a water supply project generally consists of (1) the water tariff for house service connections, (ii) the commercial and industrial supply (iii) the water tax component of the property tax of the concerned local body and (iv) the matching Government grants.

The analysis of the financial strengths and weaknesses of the local body is an important aspect of financial appraisal. The basis of such analysis is financial information obtained from the past audited accounts and audit reports and from financial projections prepared by the local body. The reliability of such information would be tested by discussions with the senior management staff and by an in-depth examination of its financial administration and accounting.

3.1. WATER TARIFF

Water Tariff is the rate levied for the water supplied to the consumers in order to develop sufficient revenues to provide for operation and maintenance and also for debt services. The tariff must attempt to distribute the cost of supply of water equitably to all consumers in relation with the benefit they derive or the expenses they cause to the system. The principle of 'paying in proportion to the cost of water used' has generally worked in advanced western countries. But in developing countries like India the funds for the implementation of water supply schemes have to necessarily come from the government either as loan or grant or both to the local bodies concerned in view of the poor financial status of the local bodies. However to make the utility self financing, water charges must be geared to meet replacement cost and operation and maintenance cost.

BASIS FOR WATER TARIFF

The total revenue of a public water supply system should be adequate to cover.

1. The cost of operation and maintenance
2. Interest and depreciation or amortization on the investment of water supply system components

3. An additional amount for implementing certain facilities like extension of distribution system, meter and service installations, periodic replacement of pumping plants which are more or less continuously taking place. It is one of the primary responsibilities in a water supply system management to see that the revenues are adequate and are equitably collected from those using the service. Water tariff fixing essentially reduces to the distribution of the expected total revenue requirements in as equitable way as practicable

among all cases of consumers, large and small. It is generally agreed that there should be different slabs or tariff for non–domestic and commercial consumers. The total revenue requirements are made up of.

i) the operation and maintenance expenses as estimated for 3 to 5 years in advance of proposed rate change.

ii) Debt service in obligations outstanding and to be issued in the succeeding 3 to 5 years

iii) Depreciation allowance of $1\frac{1}{2}$ to 2% per year on investment less unamortised debt.

iv) Estimated average annual expenditures for ordinary capital addition during next five years.

Techniques must be developed continuously and they should be based upon sound engineering and economic principles. The ability of the techniques to provide sufficient revenue and accomplish an equitable distribution of cost must be continually reevaluated.

The simplest form of water rate is a flat rate payable monthly or quarterly by the consumers regardless of the quantity consumed, the services being non metered. Many local bodies also adopt the system of a fixed tap rate charged per tap irrespective of the quantity used. This rate is easily fixed by dividing the total revenue required by the total number of consumers or taps. But this system leads to wastage of water and is therefore not satisfactory. Most equitable method would be based on metering of all supplies. The quantity actually accounted for by the meters is invariably less than that, produced. Since there is considerable wastages as 'unaccounted water' which also should be considered in fixing the water rates, some local bodies allow a free allowance for the metered supplies based on the water taxes collected and charge only for the excess. This is also not desirable as revenue collected by water rates is to finance the operation and maintenance cost fully. A worthwhile alternative is to collect a fixed charge called service charge per consumer in addition to the charge for water consumed. The fixed charge is to provide for the meter rent where the meters are supplied by the department and the overhead charges for meter reading, billing etc. The entire supply as measured by the meter is to be charged for at either uniform rate or graded rates. There must be seperate meters for measuring the supply for domestic and non domestic uses. The rates for non-domestic and industrial purposes may be fixed higher. The rates are to be carefully fixed taking into account the following:

i) The rate must be high enough to fetch the necessary revenue and at the same time not excessive as to discourage consumers from making use of water.

ii) The rate should be such as to make the amenity more or less self paying and worked on no-profit-no-loss basis.

4.0. SELF SUFFICIENCY OF WATER SUPPLY PROJECTS

Most of the water supply schemes to the local bodies are implemented with the financial assistance by way of loans from Govt. or from lending agencies like LIC, World Bank etc. The local bodies are to repay the loans with interest in annual instalments for the specified period. In addition the local body has to incur considerable expenditure on operation & maintenance (O&M) charges towards the wages of the operating staff, cost of electrical energy, cost of chemical etc. The annual repayment of capital loan and the expenditure on the O&M charges are to be met from the revenue generated from the project by way of sale of water and the proportion of the property tax collected representing water tax (water tax is usually 25% of the property tax). If the revenue from the project is equal to the expenditures ie. loan repayment and O&M charges then the scheme is said to be self sufficient or financially viable.

5.0: FINANCING OF WATER SUPPLY PROJECTS

Almost all major projects have to be financed by borrowing money as the huge capital expenditure cannot normally be met from the local body's fund. Fortunately, water is a readily saleable commodity and if water tax or water charges are judiciously levied, no difficulty should arise in the repayment of loans. Following are some of the sources from which the funds required for the capital expenditure can be raised. The local body should tap one or more of them as may be appropriate in the circumstances.

(i) INTERNAL BORROWING:

(a) Provident fund account

(b) Depreciation account

(c) Other deposit accounts.

These are the cheapest sources for capital investment.

(ii) EXTERNAL BORROWING:

(a) Public loans

(b) Government loans

(c) Loans from other lending agencies like LIC, Unit Trust etc.

(d) Advances from industries

(e) World Bank/IDA

(iii) GRANT IN AIDS:

(a) Aid or gift from local philanphroprists

(b) Grant in aid from Government State or Central

6.0. NEED FOR SUBSIDY:

In India, the tradition is to subsidise the costs of the water supply projects by diverting funds from other revenue heads. The consumers in India are not prepared to pay more for the water as water is still continued to be considered as nature's free gift to mankind. They fail to understand that though water is free at the spring it cannot be so when it is made available at the door steps.

In certain cases, the total revenue from the project may not be adequate to meet the repayment of loan and the O&M charges due to the following reasons:

(i) The capital cost of the project may be very high due to distant source involving long distance transmission main, higher pumping head, necessity of full scale treatment of water etc.

(ii) The limited capacity of the community because of low income level to pay for the water charges which is not adequate to meet the annual costs.

(iii) Limited scope for selling of water at higher rates to industries and other commercial establishment in order to cross subsidisation. One can make a water supply project viable by selecting and adopting a tariff pattern that people can afford, and if required, even by doing some internal cross subsidisation. It may be imperative that the Government should come forward to subsidise by way of grant in such cases to the extent necessary to make the scheme self supporting. The immediate question now arises is how much should be the quantum of grant. When the capital cost of the project is very high, project analysis is to be made by comparing different feasible alternatives and the one with least cost should be selected. The water supply projects are generally not rejected for reasons of not meeting an economic rate of return criterian. In certain cases, the percapita supply is reduced to the nearest minimum only to contain the total cost of the project within the financial viable limits. There is no easy way of quantifying all benefits.

In order to minimise the wastage of water in the distribution system and to charge for the actual quantity of water consumed by the consumers, it is necessary to meter all the house service connections.

A reasonable rate affordable by the consumers is fixed in order to raise the revenue required. The deficit in the revenue to meet annual cost towards capital repayment and O&M charges, is to be subsidised by the Government.

The probable % of grant for a water supply project can be worked out as follows:

Let the capital cost of the project = Rs. C
Annual revenue by way of sale of water to industries and commercial establishment and water charges from the consumers&proportionate property component. tax = Rs B per annum.
Annual O&M cost = Rs. M
Net operating income = (B–M)
Present value factor for annual payment for n years (life of the project) at i%discount rate = PVF
Probable loan L = Present value of net operating income
= PVF (B-M)
Probable grant to be sanctioned by the Govt. 'G, = C-L
Percentage grant on the Project cost $= \frac{G}{C} \times 100$

Accordingly, the Govt. grant for the project can be determined.

If the Government desires to limit the percentage grant to a particular water supply project, then the balance cost of the project is to be met by way of loan from the Government or some other lending agencies. Suitable higher water tariff is to be fixed in order to repay the loan within the specified period. In such cases the water rate can be fixed as follows.

Let
the cost of the project be Rs. C
Percentage of grant fixed by the
Government be p %

Amount of grant $G = \frac{P}{100} \times C$

Amount of loan L = C—G

Capital recovery factor for annual repayment of loan in 'n' year at an interest rate of i % = CRF

Therefore annual repayment of loan = (CRF) L

Annual O&M expenses ... = Rs. M

Therefore annual revenue required B = L—M

Annual quantity of water supplied = Q lit

Therefore water charges per 1000 lit $= \frac{B}{Q} \times 1000$

The water Tariff is fixed based on the water charges for 1000 Lit. as calculated above.

However, a public subsidy or grant from Government for water supply scheme will divert scarce financial resources from other important public services. Further more, unless subsidy is carefully restricted to assist the very poor, there is the danger that water consumption will be lavish by the affluent consumers. An alternative, often preferable approach is to establish some degree of cross subsidization within the local body's tariff structure by leying higher charges on non-domestic and better off domestic consumers thereby preserving the self sufficiency of the project.

7.0. FINANCIAL ANALYSIS

A water supply project may be financially feasible ie, self sufficient in that the funds required for the project can be generated to pay for it through water charges & taxes. However, this does not mean that this project is the best and the least cost of the available alternatives. On the other hand, a project may be economically feasible eventhough it cannot be financed. The policy of the Government may prohibit borrowing additional finance to a project in order to make its benefits exceed its cost.

The financial analysis for water supply projects is made to find out the viability of the scheme and to ascertain the extent of subsidy to be given for implementing in the case of non viable schemes.

For a complete financial analysis of a water supply project, the data such as the capital cost of the project, expected life of the project, yearwise annual operation and maintenance cost, cost required for replacement of pumps and other components during the life of the project, yearwise anticipated annual benefits by way of revenues throughout the life of the project and the interest rate at which the loan for the capital investment can be obtained should be collected.

The basic principle of the project appraisal is an effort to establish commercial or national profitability, what is required are :

(1) The identification of the quantity, quality, and timing of inputs and outputs.

(2) Estimation of values of those inputs and outputs, in order to compute the costs and benefits and

(3) Comparison of these costs and benefits with each other and with those of the alternative projects compared in a similarly consistent manner.

The principle is simple, but the application is never easy. It is to be pointed out in this context that there is considerable difficulty in making the right assumption and assigining correct values to cost and benefits and often quantification is impossible, especially for benefits.

8. O. CONCLUSION

Proper planning in project formulation and financing is necessary in order to make the project self sufficient. Some of the following principles may be considered while planning for achieving self-sufficency.

i) Fixing optimum percapita water supply to meet only the basic needs such as drinking, cooking and bathing and local sources for other uses.

ii) Metering of all the domestic & non domestic service connections.

iii) Levying higher charges as non-domestic and commercial consumers.

iv) Providing adequate Government subsidy for implementing the project, as dictated by financial analysis.

v) Fixing higher tariff rate for larger consumption (i. e) different tariff for different levels of consumption in order to minimise consumption.

vi) Providing adequate staff for operation, maintenance and management of water supply systems including for leak detection and rectification works so as to reduce the avoidable wastage. □

WHAT WE REALLY NEED...

Regarding the water supply systems the engineers, technocrats etc. all are well versed and equipped with the know-how. The latest technologies are also available and further research is continuously being done. Despite this, the experience in our country is that the projects are sometimes mis-evolved, generally over-delayed, occasionally mis-executed and as a result the benefits do not reach the society. If this state of affairs continue, a day will come when the situation will be worse and un-manageable.

Thus, what we need today is not only the engineering know-how but also the use of appropriate techniques, modern or otherwise, of the management sciences. What we further need is not only engineers but effective engineer-managers -and above all persons with dedication, integrity and pragmatism.

Compiled By B. Bijli

"Adequate water service, at a reasonable price, is an attainable objective. If it has not yet been attained, it is only because the skilled workers in this field have not seen fit to define the objective, to delineate the principles which should control its implementation, to devise the structure for administration and management, and to establish the fiscal principles which might safely and wisely provide the sinews for the project".

Dr. Abel Wolman,
John Hopkins University

Drinking Water - Sustained Availability for Survival Rural Water Supply

J. A. SPEETS
Water Coordinator,
Royal Netherlands Embassy,
New Delhi.

INTRODUCTION

Air, water and food sustain life. Air is available in nature freely. Production, processing and distribution of food involves economic and commercial efforts which are to be paid for by the consumer. Water shares the characteristics of both air and food. It is available in its raw state freely in nature but carrying the water to the place where it is desired to be consumed and making the water fit for drinking involves effort, a "one time" or occasional effort to build supply systems and "daily effort involved" in treating to bring to a health standard and transporting it to the consumer's point. Construction of these systems require technical, administrative and financial inputs. For this purpose an institution like local body, a Panchayati Raj Institution, a Government Department or statutory corporation is required. To enable these institutions to operate and maintain the water supply systems effectively and supply water without failure, the necessary adequate financial input should be available. The local bodies do not have sufficient own resources available to invest in the water supply sector. The Rural Water consumer is a weakling from the point of view of ability to pay. The capital funding comes by way of grant-in-aid or repayable loan to the producing institution from the governments, national or international financial institutions and certain foreign countries like Netherlands, Denmark etc. The recurring revenue expenditure is normally expected to be met locally. If the philosophy that water is a free natural resource and hence the consumer need not pay for it is allowed to take root in peoples mind, producing institutions will find it increasingly difficult to run the undertakings and supply water.

U. N. DECADE FOR WATER SUPPLY AND SANITATION

The U.N. Decade for Water Supply and Sanitation is ending in 1990. There is a clear trend of increase of outlay on rural water sector in the recent plans. There are 576, 141 villages in the country (1971 census). At the beginning of Seventh Five Year Plan the problem villages estimated to be covered were 1.90 lakhs. According to the action plan (1988-90) of National Drinking Water Mission, the problem villages left for coverage at the beginning of VII Plan was 161, 722. These were programmed to be covered by 1990. By 31-3-1989 140, 856 problem villages were covered and out of remaining 20, 866 villages 16, 671 villages were to be covered by 1989-90 and 4195 problem villages were likely to spill over to VIII Plan. Action plan lists as an item of "Methodology" "Promote Decentralisation of Activities of Operation and Maintenance". However, there is no specific indication about the cost recovery and financial viability of the large number of water supply and sanitation systems created in the U. N. Decade. Till now the assurances of proper maintenance of the projects under international aid and bilateral assistance are being given by the governments. But in many cases the systems are being maintained in a centralised fashion with downward flow of finance without concerted efforts at generation of resource at the users' end.

REVIEW OF POSITION OF RWS IN STATES-NEERI STUDY

The National Environmental Engineering Research Institute (NEERI), Nagpur conducted a study

for Evaluation of RWS Schemes. The findings of the survey was as follows: "systems managed by local bodies are generally entrusted to unskilled and un-trained caretakers and often suffer for want of funds. When water distribution is only through public standposts, collection of water tax is rather poor and needs lot of persuasion. The consumer often thinks that water not supplied at his door-step need not be paid for".

A look back survey in Gujarat in 1980 noticed that 22% of systems were found to be not run for the whole year. In A. P., M. P. and other states innumerable water supply systems became defunct some time or other. These experiences give an indication of poor financial condition of local bodies and consequential inadequate repairs and maintenance.

The lesson that we may have to learn from this scenario is that funding of rural water system at the maintenance stage is likely to be jeopardised if it is totally left to local bodies without higher level support. But at the same time total funding from State/Centre is beset with the problem of sufficient allocation of resource for satisfactory maintenance, since the finances of the Government themselves are limited and there are many important and urgent current requirements competing for resource allocation. There is also the danger that the scarce resource is this way tied to already developed areas during operation and maintenance stage while areas not covered by water supply at all, suffer.

ABILITY AND WILLINGNESS TO PAY/INVERTED BLOCK TARIFF

The ability as well as the willingness to pay varies, with different classes of consumers. Commercial consumers like cinemas, restaurants and industries are profit-making organizations which are willing to and are required to pay market value for the commodities they buy. There should also be an element of cross-subsidization from the industrial and commercial sector to the domestic and public sectors.

If differential rates are charged, there will remain a gap between revenue and expenditure which has to be subsidized. The tariff policy can be adopted to fill this gap by charging more from the more affluent sections of domestic consumers. One of the methods used for this is the system of Inverted Block Tariff, i. e. charging progressively more for higher levels of consumption. This will mean that the non-essential element involved in a higher level of consumption is burdened with the task of cross subsidizing the essential minimum consumption of weaker sections. Geographically, the same principale of cross-subsidization from urban to the rural sector is possible. We may call this the Principle of social Equalisation. In this, the ability to pay and the incidence of charges are considered to be more applicable criteria than equal distribution of the total aimed recovery. While ability to pay increases with income, impact of incidence decreases with increases in income. A small increase in rates may have a considerable impact on the standard of living of people below or near the poverty lihe.

PROBLEMS OF NOT CHARGING WEAKER SECTIONS

Er. R. Ramanujam states "What happens to use of water by the low income people in a system where no charges or very low charges are levied is that the poor are first to be left outside the public system as the poor have few means to influence the municipality or corporation to extend service into their areas. Hence where no charges are levied subsidies will be evenly distributed. Whoever will consume more will receive larger subsidies. Then consuming most "Per Capita" are the rich and they could best afford to pay for their services since there is distinct corelation between "Per capita Income" and "Per Capita Consumption". Thus the system with no tariffs turns out to favour the wealthier groups and discriminates against economically weaker sections of community." Er. Ramanujam advocates LIFE LINE two parts tariff. It comprises of.

(1) One fixed monthly charge for a minimum LIFE LINE allowance and thereafter

(2) A unit rate equal to the long run marginal cost (average incremental cost).

In my own experience, I observed that even distribution points in rural water supply are more widely spread in areas occupied by affluent sections of society and the consumption levels of poor people are very low even where protected water supply is available.

VIRTUOUS CYCLE

The problem to be tackled is how to apply these principles of cross subsidization to rural water supply and sanitation where payment by quantity of consumption and metering are not practical for reasons of thin spread supply points and limited individual consumption. What is required is to create a VIRTUOUS CYCLE (as a contrast to Vicious Circle) as indicated below:

Effective and efficient O&M

Recovery of Maximum possible recurrent expenses plus State support

Users satisfaction and appreciation

Education and propoganda
for local participation
and financial support

Since the assets are created by Central funding and have already come into existence in most cases, the creation of virtuous cycle vests with the creator of the asset (Government) and the agency for operation and maintenance (Local Body, Panchayat or Maintenance Corporation like Jal Sansthan in U. P.). When the need for the service is strong enough, the poor are more willing to pay even beyond their theoretical capacity to pay. It is only the comparatively more affluent who resist payment and press for subsidy in the name of the "Poor". The solution for this is to start the efficient working of the system in the first few years of construction, and ensure user satisfaction and appreciation. This should be followed by a campaign of Education and enlightenment among the local users/rate payers about the risks involved in leaving the maintenance costs entirely to government funding. The history of failures of several water supply systems due to insufficient funding has to be advertised. The relatively affluent section of the rural communities should be made to understand that the relative comfort of protected water at their door step is likely to be lost, if they do not come forward with sufficient contribution for proper maintenance. The local representatives have to be taken into confidence about the need to use the powers of taxation under Panchayat acts to levy sufficient level of "Water Tax" as a percentage of "Property Tax" and the proceeds of the tax used entirely for operation and maintenance of water supply and sanitation schemes. Since the water tax is a percentage of property tax, the principle of charging the rich more and subsidizing the weaker sections will be satisfied. Wherever the private connections are taken the charges could be based on the number of taps or the diameter of the inlet pipe but should be fixed sufficiently high since there is no metered limit on consumption. The fine tuned sophisticated methods of cost recovery do not suit the needs of water supply and sanitation schemes in rural areas for reasons of distance, disproportionate cost of pricing the quantity and the smallness of communities. About 83% of the villages in the country have less than 1000 population and the source points of water required for them are nearly Rs. 10.00 lakhs including existing sources at the rate of one point for every 200 persons. The water used for domestic purposes is only 3% of the total water used for various purposes viz. industrial, commercial, steam and electric power, agriculture, etc. The rural people in general make much less use of water for domestic purposes than urban people. Since water is perceived as essential for survival, with persistent educational and administrative effort local support will be generated. This brings us back to the need for efficient and effective operation and maintenance and continuous adequate supply of protected water the starting point of the virtuous cycle as well as the end point. The other essential feature of this situation is that the water systems should be devised for the essential level of consumption choosing the least cost alternatives, cheaper modes of retaining and conserving water and designs which take into proper consideration users' attitudes to water without neglecting site specific, natural as well as social and cultural aspects.

MY PERCEPTION OF GOVERNMENT POLICY

Rural Water Pricing is a policy question. The evidence of:

I Finance Commissions. Recommendations.

II The Recommendations of the "Working Group on Financial Resources" set up by the Apex Committee appointed by the Central Government in 1980.

III Action Plan of National Drinking Water Mission. Gives me reason to draw conclusions that:

1) Government at National Level is committed to the extension of the protected Water Supply to 100% rural population.

2) Capital expenditure on creation of Water Supply and Sanitation Systems will be centrally funded.

3) Cross subsidization from one sector/section to another is accepted in principle.

4) The operation and maintenance of rural water supply and sanitation schemes is to be decentralised.

5) The cost of such operation and maintenance is to be shared between the local rate payers and the higher level tax payers.

CONCLUSIONS AND RECOMMENDATIONS

There is no alternative to entrusting operation and maintenance to some variety of local authority. It is interesting to know that even in conservative England swearing by privatisation the recent initiatives by the government for (i) sale of water utilities to private parties (ii) private raising of money for extra roads, falling outside normal public spending discipline, have met with very stiff opposition from people. The clash between the social benefits and the revenues demanded by private operators were pointed out forcefully (ECONOMIST 13–19 MAY 1989 and 18–22 SEPTEMBER 1989). Any recommendation for action in this country should be based on the acceptance of the fact that eventually Panchayats and local authorities will have to run these water supply and sanitation schemes.

The following steps are suggested :

1) Policy perceptions to permeate to all levels.

2) Sharing of operation and maintenance costs between the rate payers/users and the higher level tax payers based on a perception of intangible public benefit should be accepted as a fulcrum on which future course of action would be based.

3) Efforts are to be made to bring within list of compulsory taxes " Water Tax " and " Sanitation Tax ". The taxes should be linked to property tax as additional percentages. The minima/maxima ,may be fixed by the government by statute or executive order keeping in view local conditions like hill areas, tribal areas etc., and also the need to ensure that there is no wide variation in the rates levied by various local authorities.

4) Private connections in rural areas wherever given should be separately charged adequately.

5) The fixation of the quantum of recovery (tax + water charges) should be so devised as to meet at least 50% of the cost of maintainig water as well as sanitation schemes.

6) The remaining 50% of the cost should be clearly perceived as a share of the State and should be so allocated in the budget.

Traditional proverb says " where there is will there is a way ". Here in fact there is a way. A simple enough way. What is required is the will. Will of the opinion leaders, decisionmakers, financial administrators and the users particularly the more well to do sections. This is an age where desire and will to purchase even not so essential goods is created by the slick projection and advertisement through visual media We should be able to use the same media to create awareness of the requirement of financial viability of the systems running such essential requirements as drinking water and sanitation. PEOPLE UNDERSTAND. □

THE ROLE OF MAN

Life owes its existence and obtains its subsistence, growth and fulfilment from the environment, which is the product of complex and dynamic interaction of physical, chemical and biological and social systems. The fact that the quality of life is linked with the quality of environment is evident to us from the time of man's known history. In the natural ecosystem man has always played the role of destroyer, remover and improver of various components which cause lot of disturbance in the ecological balance. Man is the one who pollutes and contaminates the water environment and again he is the one who tries to retrieve the same from the pollutants and the contaminats.

Compiled by B. Bijli

Can Rural Water Supply Schemes Be Made Self Supporting?

Sri. N. P. GOVINDAN KUTTY,
Chief Engineer (Retd) K W A.

In his interesting article "Drinking Water Supply Decade (1980-'90) A Challenge", in IWWA Journal Vol. XI, April-June 1979, No. 2. (Ref. 1), Dr. B. B. Sundaresan, erstwhile Director of the NEERI and past president of the IWWA has expressed the following opinion. "The concept of commercialisation of water supply as a self-supporting proposition, though relevant for urban conditions can seldom gain acceptance in the rural set up. The approach for rural water supply should be different from those for urban system...". The commercial viability of a scheme depends on the paying capacity of the beneficiaries and not on the rural or urban nature of the community. In developed countries, water supplies in rural areas are also self-supporting. So the financial viability of a scheme will depend on the awareness of the members of the community about the necessity of a protected water supply for warding off water-borne diseases and on their economic capability. Let us consider the financial burden of a rural water supply scheme under Indian conditions. In the same article, Dr. Sundaresan has given the estimate costs for the decade programme for urban and rural water supply schemes. He assumes a per capita cost of Rs. 300 for urban schemes and Rs. 150 for rural schemes benefitting population between 1000 and 10000. These figures assumed seem to be rather on the lower side, since the cost under Kerala conditions works out to Rs. 300/ capita for schemes coming under the ARP, the population covered in most cases exceeding 10000. The capital cost of urban schemes are also much more than that given in the article. The average cost comes to Rs. 700/ capita. The lower cost of the rural schemes is mainly due to the lower rate of consumption allowed (40 litres/capita/day for rural scheme is allowed against 150 to 200 litres/capita/day for the urban schemes, the extra cost of treatment plant which are usually provided for only urban schemes being about Rs. 50/ capita only). The adoption of ARP norms seems to be rather retrograde from the public health point of view. In these norms, the supply is to be given only through street hydrants and no house connections are to be given. Studies in California and Bazil (Ref. 2) have shown that unless protected water supply is given in the house-hold premises, the benefit of controlling the water-borne diseases becomes limited. So as a control measure of water borne diseases it is better to give at least one tap within the premises of each household The design period norm of fifteen years also seems to be unrealistic. It entails an expansion of the scheme within ten years of its completion. A longer design period will surely be ultimately more economic and desirable considering the fact that in the more distant future it is more likely that the beneficiaries will become economically capable to financially support their own schemes. Another penny-wise pound-foolish practice in ARP schemes is to reduce the size of distribution main even to 25 mm while standard practice is to use a minimum size of 80 mm. This is only a digression about the short-sighted norms of the ARWSS, perhaps adopted to achieve greater coverage with limited funds.

Coming to our problem, let us consider a rural scheme benefitting 20000 people. A higher per capita consumption of 70 lpcd is assumed in order to give house-service. A per capita cost Rs. 400 is assumed. There is no treatment except disinfection. Water supply is restricted to four hours in the morning and four hours in the evening. Debt Servicing at a low rate of 6% interest and long period of repayment of 50 years is assumed. The operation and maintenance cost is assumed to be Rs. 10/ capita (average cost from Kerala experience.) The annual return required to break-even is worked out below.

Annual operation and maintenance cost		...Rs. 2,00,000/-
Annual debt service charges		...Rs. 5,06,000/-
Depreciation	(50 years life assumed	...Rs. 1,60,000/-
	Total	Rs. 8,66,000/-

With average strength of five, there will be 4000 households in the community. If one tap connection is given to each house-hold, and 1000 house holds are exempted from water charges since they are below the poverty line (The seventh plan target is to limit population below poverty line to 25%,) the monthly charge for house-hold works out to Rs. 30. This is too much for even a well-to-do rural house-hold under the present circumstances. If the capital cost is given fully as a grant and depreciation is omitted (There is some justification to shift this financial burden to the future generation which is expected to be much more better off economically) the monthly house-hold charge will work out to less than Rs. 6/ month. The poverty line annual income of a house hold with five members is Rs. 6400 (Ref. 3). The average income of 3000 house-holds above the poverty line will be more than Rs. 10000/ year. So six rupees per month will not be a burden. So the strategy should be to get the capital required as a grant in full. The local body should be strengthened constitutionally and financially. Though very late, the Government of the country is looking into this matter. The charges can be collected as a surcharge on house tax entailing no additional collection charges. As peoples' standard of living increases, the charges can be gradually increased and made to cover depreciation also. So the vital point is the improvement in the standard of living. If this can be achieved rapidly then rural water supply can also be made self-supporting The golden examples are Japan and South Korea. In the same issue of the IWWA journal (ref-1) which I had quoted at the beginning of this article, there is another article by professor Ishibashi, President IWSA, London titiled " Water Supply problems in Japan ". He points out three causes for rapid development of water supply in Japan. (from 35% coverage in 1952 to 89% in 1976 consisting of 93.5% incities, 74% in townships and 65.3% in village).

1. Rise in standard of living
2. Gradual steady development in economy
3. Public awareness of the importance of water supply and their demand for financial assistance from the national Government, wherever necessary, through the elected representatives.

So creating awareness among the public of the importance of protected water supply is very important as well as fairly rapid, steady, balanced and equitable economic development. In India, where the literacy level is still below 40% (there are more illiterates in India today than when she gained independence) and economic development is very slow, the attempt to fix a decade target of 100% coverage for water supply can be looked upon only as a case of "putting the cart before the horse". The actual coverage in Kerala with respect to water supply, at the end of the decade is only 35% in rural area and 70% in the urban area. Of this, the decade achievement is only 19% in the rural area and practically very little in the urban area. So there is no other way but rapid and equitable economic development to make our water supplies and such other socially beneficial infrastructures self-supporting.

1. IWWA Journal, Vol.XI, April-June 1979. No. 2
2. Water Supply for Rural Areas and Small Communities E. G. Wagur and J. N. LANNOIX, WHO Monograph 1959.
3. Indian Economics - B. K. Bhargava, Sudha Publications, Private Ltd., New Delhi 110 008.

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Financial Viability of Drinking Water Supply Schemes: A Kerala Experience

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ABSTRACT

This paper discusses various issues arising out of the responsibility of the government to provide facilities for drinking water in the State. The impact of the management philosophy of drinking water sector on financial viability of schemes and the sector scenario in Kerala is indicated. The lack of a definite policy as to whether drinking water facility is to be treated purely as a subsidised welfare activity of the government or to be considered as a self-supporting service industry is pointed out. The importance of data base planning and design of schemes is stressed. The need for a fresh look at the sector management philosophy based on the experiences in the State for a healthier future is highlighted.

1.0 INTRODUCTION

1.1 The issues arising out of the social responsibility of government to provide facilities to satisfy the basic need of drinking water for the people are many: capital cost, service levels, maintenance cost; terms of service to the beneficiaries, financial capacity of beneficiaries, responsibilities of the beneficiaries, financial capability of government and local bodies etc. All these complex issues are to be approached within the frame-work of drinking water sector management policy, to benefit both the people and the government

1.2 In accordance with the U. N. call, India also adopted 1981-90 as the 'International Water Supply and Sanitation Decade' with the objectives of giving everybody access to drinking water and a certain degree of sanitation by the year 1990. This stimulated public and governmental awareness and promoted the development of a firm political commitment towards water supply and sanitation sectors. In the drinking water supply sector, India was able to provide facilities to 72.9% urban and 56.2% rural population by mid-decade (Mid Term Review of Water Decade Programme, Government of India, 1985, p. 17).

1.3 In Kerala State, to mobilise resources and for accelerating activities in drinking water supply and sanitation sectors, the erstwhile Public Health Engineering Department was converted into an autonomous body 'Kerala Water Authority' by the promulgation of an Act. The Act also stipulates that for any project to be undertaken by the Authority, it shall enable to meet as soon as feasible the cost of its operation, maintenance and debt service and when practicable to achieve an economic return on its fixed assets. Thus the Act deviates from the concept of a mere subsidised welfare activity to a self-supporting one.

2.0 DRINKING WATER SUPPLY: A WELFARE PROGRAMME

2.1 In Kerala State, drinking water supply was considered only as a part of the welfare programmes of the government and the people's fundamental right to get it free. Even now, after the formation of the Kerala Water Authority which has financial return also as one of the objectives, the same philosophy prevails among the authorities, planners, implementors and the people at large without any concern for the financial viability of the schemes. Even though providing safe drinking water to the people reduces government's expenditure in the health sector, can the government provide the

facility at any cost? The Government of India also, while sanctioning grants, did not consider financial viability as an important parameter of schemes.

3.0 DATA BASE FOR PLANNING

3.1 Importance of an adequate and dependable data base for conceptualisation and planning needs greater emphasis as many piped drinking water supply schemes in the State were prepared in great haste without sufficient and reliable data. Generally sources were selected based on flimsy and unreliable information without contemplating the later consequences. The project proposals prepared in great haste with the objective of lgetting financial assistance resulted in mere financia loan documents rather than properly conceptualised and designed schemes based on real data which could be translated on to the field. The project estimates were also unrealistically low because of inadequacies.

3.2 In Kerala which has a ribbon development, unlike other states, formulations of projects without an overall conceptualisation of the area resulted in the formation of a network of many small schemes with high production costs covering only a limited population. This caused enlarging the scope of the scheme during execution, stretching the capability of the scheme to its maximum level and sometimes even beyond. Thus the schemes, in reality, lost effectiveness and at the same time over-ran budget provisions. Implementation of such projects resulted in huge maintenance deficit also creating difficulties for the State government to allocate sufficient funds for maintenance. In addition, implementation of small schemes, covering only portions of villages under 'Accelerated Rural Water Supply Programme', rendered further funding for enlarging the scheme extremely difficult.

4.0 INFORMATION - INTERACTION - PEOPLE'S PARTICIPATION

4.1 For well prepared drinking water supply projects, information generated through interaction of people is the basis. In Kerala, there was not enough people's participation in the past at the planning stage of the water supply projects resulting in short fall in coverage, leading to dissatisfaction amongst the people. To achieve effective full coverage of the State, a comprehensive master plan covering the entire area is necessary, but this also was not available in Kerala. For proposing a comprehensive master plan for a district, areas of full, partial and no coverage are to be identified clearly. This can be effectively done only by participating peoples' representative who have direct and reliable data. With this in view and with the idea of eliciting the requirements of the beneficiaries, workshops on master plan on drinking water supply schemes for some districts were conducted by the Investigation and Planning wing recently in the State. The outcome was very encouraging as considerable interaction emerged and substantial and useful information could be generated from the discussions.

5.0 PIECE-MEAL PLANNING VERSUS COMPREHENSIVE PLANNING

5.1 As indicated, piece-meal planning of a network of schemes in the state resulted in uneconomical designs with respect to the major components of the schemes viz., intakes, pumping mains, treatment works, storage tank etc. For example: in a situation where one intake well could serve a large scheme area, intake well for each small scheme had to be constructed which caused increased capital outlay and operational costs owing to the duplication of pumping mains and intake wells. The case is similar with respect to other aspects as well.

5.2 In piece-meal planning exercises appropriate scheme areas cannot be identified. There are instances where certain areas are left out of the scheme and also in between schemes. Providing drinking water to these areas later is found to be more expensive and ineffective as the adjacent schemes do not have the necessary capacity.

5.3 Funds may not be available always to take up a full scheme as envisaged. In such situations, comprehensive schemes should have enough flexibility for being taken up in parts and for enlarging the scheme at a later date. This will minimise duplication and reduce costs compared to independent small schemes. In the context of Nagarapalika and Panchayat Raj bills coming into effect, the extent to which the bills will affect water supply sector and how comprehensive water supply schemes can be implemented and maintained economically are to be examined.

6.0 UNIT PRODUCTION COST OF DRINKING WATER

6.1 Cost of production of protected drinking water is, perhaps, more important in the long run for the Kerala Water Authority than the cost of implementation of a scheme. The cost of implementation is usually met by bilateral assistance, loans from financial institutions and grants from Central and State Governments. But the maintenance charges (production cost) and debt services are to be met by the Kerala Water Authority. Earlier, when the number of schemes were not many, the maintenance deficit was within the capability of the Government, schemes were taken up at any unit cost of production. Even though some grants from the State Government may be forthcoming for this now, when financial resources of the government is scarce, the success of drinking water supply schemes in the long run will depend on the cost of production and the return generated from the scheme. Now a situation is reached wherein it may be difficult for the Kerala Water Authority to take up schemes which are not self-supporting.

6.2 A survey of the existing piped drinking water supply schemes in the State conducted by the socio-economic unit of the Kerala Water Authority revealed that the cost of production of drinking water per 1000 litres (without allowing for depreciation, debt service, etc.) varied considerably from small to large schemes For small schemes (daily supply less than 50,000 litres) the average production cost is Rs. 2.72/1000 litres, the maximum being Rs. 15.22/1000 litres; for medium schemes (daily supply between 50,000 and 1,00,000 litres) the average production cost is Rs. 1.72/1000 litres, the maximum being Rs. 4.86/1000 litres and for large schemes (daily supply more than 1,00,000 litres) the average cost is Rs. 0.84/1000 litres, the maximum being Rs. 3.67/1000 litres. Taking the Kerala Water Authority as a whole, the total annual maintenance cost of all the schemes (excluding debt services) and the annual collection from 1984-85 to 1987-88 are given in Table-1. This clearly reveals the increasing financial deficit the Kerala Water Authority is running into, owing to increased production cost and to the non payment of maintenance and water charges by the local bodies which also do not have sufficient financial resources to meet this expenditure.

Table–1

MAINTENANCE EXPENDITURE AND

COLLECTION OF REVENUE FROM WATER SUPPLY SCHEMES IN KERALA

Year	Maintenance expenditure (Rs. lakhs)			Total expenditure including 22% share debit	Collection (Rs. Lakhs)			Mace collection deficit (Rs. lakhs)
	Urban	Rural	Total		Water Charges	Mace. Charges	Total	
1	2	3	4	5	6	7	8	9
84-85	549	160	709	865	98	34	132	733
85-86	679	246	925	1129	119	77	196	933
86-87	759	314	1073	1310	176	132	308	1002
87-88	...	...	1356	1654	335	137	472	1182

7.0 ISSUES ARISING OUT OF DRINKING WATER SERVICE LEVELS

7.1 The performance of drinking water schemes depends on its continued maintenance. If the Kerala Government is willing to meet the maintenance cost and debt services just as subsidising the health and education sectors, drinking water can be given free to all as a part of welfare activity. If that is not practicable within the limited financial resources of the State, the only other alternative is collecting the cost from the beneficiaries. If the poor people are to be provided drinking water free, this component of the cost also will have to be collected from the other not-so-poor beneficiaries. It is a policy matter which is to be decided by the government. In this context, it is to be noted that pricing of drinking water will result in reducing waste and the revenue generated will help in providing better service levels to the people.

7.2 Thus, piped drinking water supply system serving both the rich and the poor and where only the poor is to be served free through street taps, the scheme should have the built-in capacity to provide domestic connections also in a balanced proportion to people who can afford it. This will enable the Authority to generate enough revenue to make the scheme viable in the long run. In accelerated piped rural water supply schemes, house connections cannot be given as there will not be any provision for this. Hence such systems which are coming out in increasing number in Kerala will lead to collapse of the systems because of large maintenance deficit which neither the government nor the local bodies will be able to compensate. Pattern of development and source availability in Kerala are different from other parts of the country and as such, the Central government should take a different view regarding the State while sanctioning grants to include provision for house connections so that the capital assets created will have continued utility by providing the intended services to the people.

7.3 In a situation where there is no possibility of house connections, alternate spot sources like hand pumps or very small systems of wind mill pump and bore wells to serve 3 to 6 taps, the maintenance of which can be entrusted to peoples' committees, are to be preferred if feasible. Small piped water supply schemes of only street taps with high production cost should not be taken up, unless government guarantees its maintenance cost.

8.0 PEOPLE'S RESPONSIBILITY TO DRINKING WATER SUPPLY SCHEMES

8.1 The beneficiaries in the State now are not aware of their true responsibilities due to inadequate participation with the people; they assume that free drinking water is their right.

8.2 People should realise that drinking water is a costly scarce resource (not a free gift of nature) and that it is necessary to preserve this unavoidable house-hold item as much as possible by preventing wastage and economising its usage. If the government do not consider providing drinking water as a mere subsidised welfare activity, then a suitable drinking water pricing policy is to be evolved through interaction of people to make them pay for the water they consume. During the master plan workshops conducted in some of the districts, the responses to these aspects from the peoples' representatives were very encouraging indicating that the various issues connected with the drinking water supply schemes can be solved through interactions.

9.0 DRINKING WATER SECTOR SCENARIO IN KERALA STATE

9.1 A mid-decade review indicated that the State achieved drinking water coverage of only 69.5% of urban and 40.8% of rural population (Mid Term Review of Water Decade Programme, 1985, p. 18). But these reported achievements did not reveal the true population coverage due to unrealistic norms; the real coverage as indicated by our study is only about 27% even at the fag end of this decade.

9.2 As pointed out earlier, substantial deviations from the sanctioned proposals both in design and scope during implementation resulted in heavy cost over-runs of the schemes, many of which still remain incomplete owing to financial paucity. It is estimated that about Rs. 200 crores will be required for completing the existing incomplete schemes. Thus large amounts of the vital scarce financial resource (debt capital and grants) have turned out to be dead investments.

9.3 There are many schemes in the State which are adversely effected by non-availability of water even before commissioning and drying up of the source and/or water becoming unacceptable after commissioning. There are schemes which cannot

be operated at the desired level owing to depletion of water at source. Most of the rivers run dry during summer and the increased demand during this period, in effect, de-link the system from the people causing great hardship to them. In the allocation of river water in the State, priority for drinking water sector over power generation and irrigation is yet to be fixed.

9.4 In the State, there are about two dozen completed schemes (serving a population of above 50,000) and about 1400 completed small rural water supply schemes. A recent survey indicated that most of the schemes are not operated at the desired level with respect to quality and quantity of water due to inadequate maintenance. This situation will only worsen in the future if schemes with high maintenance deficit are added on to the Kerala Water Authority without finding financial resource for maintenance.

10.0 ROLE OF THE PLANNING WING

10.1 In any organisation, planning determines the health of the organisation. Only future will reveal the effects of planning of today. For financial economy and continued viability of drinking water supply projects, the planning wing which is the backbone of the organisation should play the most important role. The personnel who man the planning wing should have high conceptual ability together with technical competence.

10.2 Considering the importance of planning, the Kerala Water Authority recently formed a separate planning wing under a chief engineer. After the formation of this wing, it was possible to re-examine many of the project proposals awaiting final sanction and redesign them to effect considerable savings both in capital and maintenance costs. Though a separate wing is created, posting to the 'Planning Wing' is looked upon as inferior to the execution wing. This wing has become a dumping ground for the not-so-influential, unwanted and below average personnel. The authorities forget that the State as a whole will suffer in the future from the effects of improperly conceived and designed schemes of today.

10.3 If the responsibilities of the planning wing is properly conceived, it could be seen that its activities should spread over to almost all of the areas where deficiencies are indicated in this paper. It is the responsibility of the planning wing for an overall conceptualisation of how the different areas are to be covered with drinking water supply. This wing should collect all the relevant data including those by promoting peoples' participation, necessary for the design of an appropriate project of reasonable unit cost of production and for fixing service levels by striking a reasonable balance between capital cost, recurring cost and the expected service terms to the beneficiaries. There should be proper interaction between the planning wing and the execution wing to enable the planning wing to get the necessary feed back in order to avoid defects in the future plans. With proper interaction and feed-back, planning wing could be made more responsible and accountable for the defects in the scheme which will force them to do a better job and will result in worthy projects.

11.0 SUMMARY AND CONCLUSIONS

11.1 The existing scenario of the drinking water sector in Kerala State, the management concepts and some of the problems that are being faced now particularly with respect to financial viability are highlighted. No doubt the present situation is the result of the sector management concepts and planning of yester years; the lack of definite policy of government towards drinking water pricing added more confusion. It is likely that similar situations also prevail in other states also.

11.2 The drinking water sector management philosophy is to be made clear to the planners and the implementors. Within this framework appropriate conceptualisation of the scheme is to be understood as the most important step in the formulation of a worthy project. The practice of proposing schemes in haste with inadequate and incorrect data as loan documents is to be stopped. As far as possible, in Kerala State, considering the development pattern, comprehensive schemes with provisions for house connections should be selected to avoid duplicating cost and to bring down unit cost of production. In areas where the possibility of generating revenue is less, cheap alternatives like hand pump, should be encouraged if feasible to reduce recurring cost. The tendency of providing piped water at any unit cost of production is to be discouraged. For these to be effective, planning wing should be considered as the backbone of drinking water sector and should be equipped with competent personnel, with more

responsibility and accountability. There should be close interaction and co-ordination for feed-back between the planning wing and the implementors.

11.3 The beneficiaries are to be educated through interaction exercises to realise that drinking water is a costly scarce resource and that one should pay for the water consumed (if that is the policy of the government). As far as possible, the water rates are to be judiciously fixed and collection system improved to generate funds from the scheme both for maintenance and for debt services. If the government has no intention to subsidise the maintenance deficit in full, drinking water projects are to be conceived as self-supporting service industry rather than mere subsidised welfare activity.

11.4 If the state of affairs so far in Kerala is any indication, it can be presumed that financial situation in this sector will only become worse in the years to come. A fresh look at the prevailing concepts and policies by the authorities (both the Central and the State governments) towards the various aspects of drinking water sector is the need of the hour for ensuring a healthier sector in the years to come. □

PESTICIDES AND FERTILIZERS—A POINT TO PONDER

Numerous Water related issues have appeared on the surface during the last three decades. One such relates to the impact of chemicals (pesticides and fertilizers) on various components of the water environment. Many professionals of today desire the need of balanced environmental decisions giving adequate attention to various economic, social ecological, technical and political aspects of water related environment. Thus public attention has been directed more to the environmental implication of environmental issues in general and chemicals issue in particular. On the one side there are positive facts that the use of pesticides and fertilizers have been responsible for (a) the green revolution around the world (b) improved comforts (c) better health and on the otherside they are at the head of the list responsible for (a) the highest number of fish killed and aquatic life destroyed in streams in various parts of the world (b) irreversible damages done to ground water by the percolation of the precipitated water carrying chemicals from pesticides and fertilizers (c) ecological damage, indirect economic loss and adverse aesthetic impact.

Thus it has become the duty of the water scientists to make their judgement and decision one way or the other on the basis of adequate fundamental scientific facts and information which should be gathered, thoroughly sifted, and analysed.

—Compiled by B. Bijli

Management of Major Water Supply Projects-Some Salient Features and Role of Consulting Engineers

by
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INTRODUCTION

Recently a number of major water supply projects have been implemented in India. Some of these projects are still under various stages of implementation. "Tata Cousulting Engineers" (TCE) have been associated as Consulting Engineers with such projects in the major cities of Bombay, Ahmedabad, Hyderabad and Madras. Of these, the largest scheme which is aided by World Bank is at Bombay involving investment of over Rs. 825 crores beginning from 1974 in three stages (I, II & III) with supply increase of 300 MGD and almost doubling the water supply to Bombay city from about 325 MGD to 625 MGD. TCE are prime consultants for Stages II & III. Stages I & II of this project have been completed and stage III works have just started. TCE's associates on this assignment are M/s Binnie & Partners (India) Ltd. of UK, (B&P) who are providing limited assistance in specific specialist areas such as Water Treatment, etc. For stage I of this project B&P were prime consultants with TCE as their associates.

2. Based on the experience gained in preparation of Feasibility Reports for approval by the World Bank and in detailed engineering as well as project implementation on the above projects we would like to share some of our thoughts on management of planning and execution of such large projects. Considering the short time available for preparation of this paper, only important aspects have been briefly touched in the paper. Authors propose to elaborate them while presenting the paper and during the discussions on the same.

OVERALL PLANNING

3. In order to avoid cost and time overruns in implementing any major Water Supply Project, it is very essential that proper approaches and precautions are taken right from the beginning. Any Project planned for execution has to properly integrate with the existing water supply as well as possible future extensions in about 25 years period after completion of the project under consideration. In order to achieve this, a "Master Plan" for Water Supply covering the status of the present water supply and demand, likely increase in demand due to increase in population, commercial activities, available water resources and overall schemes for development of same progressively to meet the increase in demand etc. should be prepared before launching any new scheme. Such master plan will clearly spell out overall stagewise development of water supply to meet likely growth in demand. Our experience is that any major water supply scheme takes between three to five years (or even more in case of some major cities) period for initial planning, investigations, feasibility studies, designs, cost estimates, arranging of funds including aid from agencies like the World Bank and Asian Development Bank,

award and actual execution of the contract followed by commissioning. Thus it is very essential that the project implementation period is considered for stagewise development.

PREPARATION OF FEASIBILITY/DETAILED PROJECT REPORT

4. Before taking up any scheme for execution it is essential that a Detailed Project Report (DPR) is prepared for same. In some cases project identification report and feasibility report precede the DPR.
5. Whenever the project authorities are intending to seek the financial assistance from the World Bank / UNDP / Asian Development Bank or other international funding agencies, the project reports need to be so prepared as to satisfy the information requirements of the different agencies.

6. Three levels of project preparation as given below are foreseen for projects of variable complexities.

a. Identification Report

b. Pre Feasibility Report

c. Feasibility Report

7. Project Identification Report provides minimal information just sufficient to determine how a project fits into a development or assistance programme and to attract financial support. This report provides an overview of existing facilities, the need for the project, a brief description of the project and its alternatives and the order of magnitude of costs involved. This report is normally based on desk study relying primarily on existing information.

8. The prefeasibility stage provides considerably more information which permits selection of preferred alternatives and may suffice for relatively simple projects. The feasibility stage finally provides the full justification necessary for the complex and large projects. The prefeasibility report is based on limited data supported by surveys to obtain preliminary estimates of critical items, whereas the feasibility report confirms the rationale for selecting the preferred project. Feasibility Report provides preliminary designs and cost estimates based on considerable data analysis. Feasibility Report also spells out the proposed institutional arrangements for implementing the project and subsequent O&M of the facilities provided in the project.

9. In case of major projects normally all these three stages are required to be undergone and the feasibility report forms the basis for the appraisal and investment decision by the financing agency after which implementation could proceed without delay.

ENVIRONMENT IMPACT STUDIES

10. Before taking up any major water supply scheme which involves development of a major water source in form of a reservoir by constructing a dam across a river it is essential to take up Environment Impact Study (EIS) which clearly brings out effcts of such reservoir on surrounding environment. This is a major study involving considerable time, effort and money. Financial institutions like World Bank and state as well as central government insists on such study and they clear the project only after all such aspects have been carefully looked into.

LAND ACQUISITION

11. Immediately after the project is cleared by all concerned authorities and possibility of obtaining necessary funds is established, it is essential to initiate steps for acquiring necessary land for various components of scheme as this is a very time consuming activity. It is our experience that projects have been delayed by many years due to delays in acquiring land.

PREPARATION OF PROJECT EXECUTION SCHEDULE

12. It is very essential to prepare a very realistic project execution schedule in the form of Project Network Schedule or PERT for the project. For this purpose it would be advisable to subdivide the project into number of contracts depending upon the magnitude, nature and location of the project. The size and scope of individual contract should be so selected that it would be within capabilities of adequate number of contractors. Generally based on our experience it is felt that separate contracts should be invited for civil works, mechanical and electrical plants for most of the components of project with the exception of perhaps water treatment plant which can be a Turnkey Contract including process design, design and construction of civil works, supply and erection of mechanical and electrical plants, testing and commissioning. However, the choice of turnkey or itemwise contract has to be made by the executing authority depending on their past experience of local

contractors. The project PERT should clearly indicate interdependencies between various contracts duly considering activity timings from practical point of view. This exercise is very essential to decide proper programme of award and execution of various contracts. This also enables allocation of funds properly and as required.

PREPARATION FOR INVITING AND EVALUATING TENDERS

13. In case the project is funded by the World Bank it would be necessary to follow their guidelines for inviting and evaluating the tenders. These guidelines are available from the World Bank. Similarly World Bank also expects borrower to follow conditions of contract given in their Sample Bidding Document (SBD) with modification where required to suit local conditions and practices. However such modifications need prior approval of the World Bank so as to avoid delay in clearance of the Tender Document by the World Bank before actually inviting the tenders.

14. We have also found that holding Pre-Bid Conference helps considerably to give clarifications to prospective bidders on the Tender Document. Such clarifications help in obtaining most competitive bids.

PREQUALIFICATION OF CONTRACTORS

15. For all major contracts the World Bank insists on Prequalification of Contractors. We have also found that this is a very good practice. Separate prequalification documents are prepared for civil works, mechanical, electrical and treatment works giving clearly criteria of prequalification in respect of past experience of execution of similar jobs (atleast of 50% of magnitude of work for which prequalification is called for), Financial soundness, availability of technically qualified manpower, construction plant and equipment available with contractor. Minimum expected qualification in respect of all these items has to be specified for guidance of bidders. It should be clearly indicated that contractors meeting with these minimum requirements only will be prequalified. System of giving marks is found to be more defective and hence we have not recommended the same in the projects executed by us and has been accepted by our cients.

ORGANISATION STRUCTURE AND ROLE OF CONSULTING ENGINEER

16. For successful implementation of any major water supply scheme the authority executing the same must have a proper organisation structure- a division independent of the normal operation and maintenance functions such division should be headed by a Chief Engineer & staffed with adequate supporting staff (technical, administrative and accounts). There should be independent "Project Planning and Control Cell" (PPCC) to monitor the progress of project and report it directly to the top Executives and head of the executing authority. Such procedure gives unbiased and independent feed back on the project to them and enables taking corrective measures well in time to avoid costly time delays.

17. Competent consulting engineering firms with experience in handling engineering and management of major projects are available to assist project authorities right from the stage of preparation of feasibility study to execution and commissioning stages. Role of consulting engineer with his exposure to many similar projects greatly assists the client organisation in formulating the project proposal with due reference to optimisation of various systems, preparation of specification and in achieving the quality control for works and equipments to the required standards. While client organisation have experienced engineers, their day to day preoccupation with operating systems does not permit them to perform the same function as could be done by consulting engineering firm to enable effective planning and implementation of the project. Some of the specific contributions that could be had by associating a consulting engineer are listed below:-

a) The consulting engineer acts with complete professional independence and without any financial interest in construction, supply of materials and plants thereby ensuring complete freedom from conflict of interests.

b) The designs are essentially completed well in time before construction sometimes even before award of construction contract thereby minimising the risk of unforeseen problems during execution vis-a-vis provisions in the contract. Consulting engineer can avail the latest technology available abroad for designing specialised areas of water supply project viz Dam, Treatment Plant, Tunnels and variable speed pumping plants etc by associating himself with reputed foreign consulting engineering firms if required.

c) The scope of construction contracts is well defined yielding better competitive bids.

d) Tender adjudiction is done independently without any bias.

e) Vendor drawing review gets expedited due to previous experience of consultants on similar jobs.

f) Problems faced during actual execution of contract are expeditiously resolved with consultant's past experience on similar jobs.

g) Better quality control and progress can be achieved by consultant's constant interaction with contractor.

In short we can summarise that expert professional advice is enjoyed by client in all stages of work due to consultant's role in the project execution.

CONCLUSIONS

18. The foregoing paras have highlighted some of the prime aspects and facets of conceiving and implementing major water supply project through the various stages. The role of consulting engineers in effectively formulating the project concepts, design and implementation is also highlighted. Many projects in India are to some extent affected due to lack of planning and lack of proper technical inputs which result in heavy time and cost overruns totally out of tune with the limited financial resources to be spent on appropriate engineering inputs at various stages of a project.

□

DESIGN–WHAT DOES IT MEAN ?

Design means determination of what is to be built and preparation of instructions needed to get it built. It dominates structural aspect; construction is sub-servient to the intentions of the designer. There must be nothing in the structure or scheme not foreseen by the designer, although excellence in the construction can perfect the beauty of a good design.

Compiled by B. Bijli.

SUCCESS OF A PROJECT

The succers of any project is measured by quality and productivity. They are again dependent on

(a) Experienced good workers, technicians and Engineers. They will always be scarce in a developing country. Labour productivity is vital.

(b) Right type of equipment and maintenance.

(c) Right materials at right quantity at right place at right time.

(d) Cash flow.

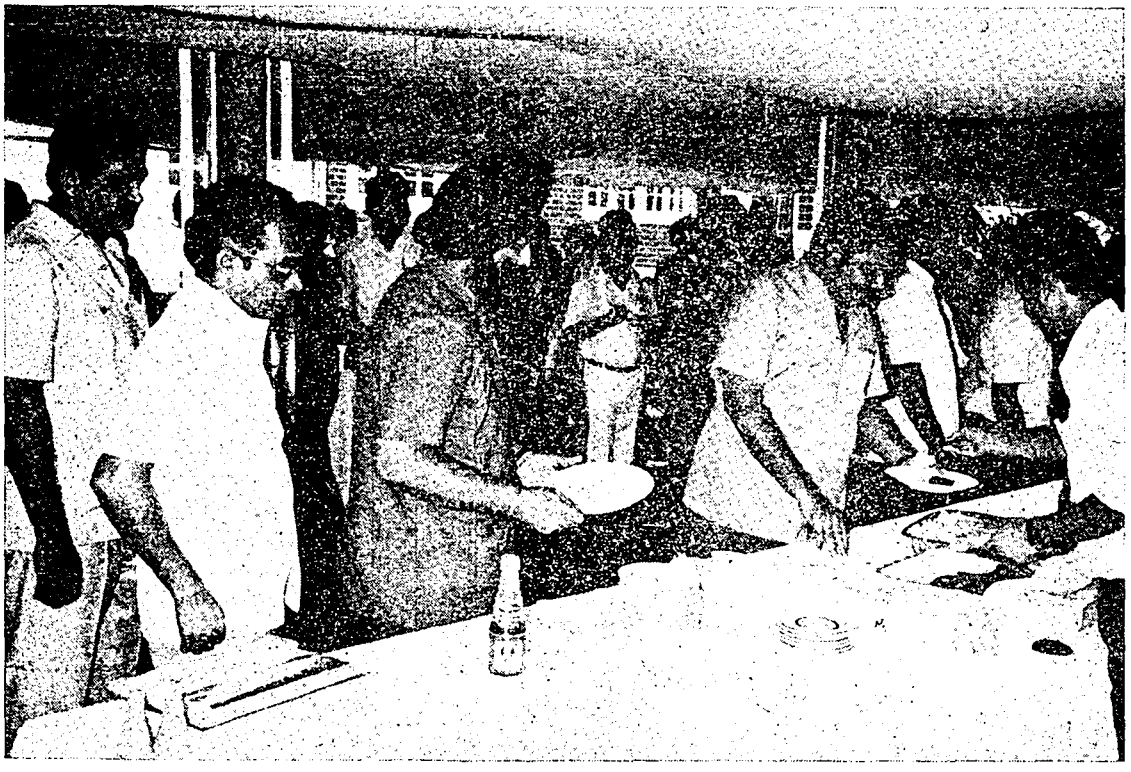
Compiled by B. Bijli.

TECHNICAL SESSION - 2 MANAGEMENT

Delegates in Kanakakkunnu Palace

Working Lunch between Sessions

A section of the audience



Tea break before valedictory function

Integrated Water Resources Planning

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ABSTRACT

Water is an integral part of man's environment. The quality of his life is controlled by the extent to which it is abundant or scarce, clean or polluted, beneficial or destructive. Rapid development of human civilization and advances of scientific and technological developments are changing the face of our planet giving rise to fundamental transformation of the environment in which Water Resources play a significant role.

But water can no longer be taken for granted. It is a limited and valuable resource. Population growth, agricultural, economic and hydropower development, pollution of water supplies and poor efficiency of water use have raised serious problems.

Available water must, therefore, be optimally developed and used most beneficially under appropriate priorities of use consistent with the requirements of the region.

INTRODUCTION

India has a rich heritage of water resources planning. The history of water resources planning dates back atleast to the golden days of King Bhageerath who tamed the mighty river Ganga and promoted irrigation and water supply in the country. In the pre-independence era, irrigation schemes have been planned and executed on a large scale. After independence, irrigation, hydropower development and water supply schemes were given due priority.

Inspite of all efforts made so far, many parts of the country is experiencing shortages of drinking water, power supply and irrigation facilities. The four metropolitan cities and other fast growing urban areas suffer from acute water shortages. Floods and drought continue to work as major impediments to the progress of the country. In addition the two major factors which cause anxiety are.

i) Increase in population

ii) Pollution

Mounting population and improved standards of living are pushing up demand for food and fibre. The available water resources will therefore have to satisfy the increasing demand for irrigation. The process of urbanization demand for greater water supplies. Pollution poses an additional hazard. One unique quality of water is to cleanse itself in the hydrologic cycle. But although fresh water is a renewable resource and may be sufficient for curren t human needs, increased use of commercial fertilizers and pesticides and generation of new complex wastes are adding more and more to the dimensions of water pollution. This is becoming a major problem in all the rivers. The salt water intrusion to the coastal aquifers continue to be a severe problem along the coastal area of the country.

Coming to the Kerala scenario it has to be mentioned that we were always proud of her water wealth. With high annual rainfall and 44 rivers Kerala was ever considered a state without much

problems in water resources. During the past few decades our State was marching towards progress in irrigation, water supply, hydropower development and related fields. At a time the quantity of storage and amount of hydropower generation was considered as an index of the proper utilization of our water wealth. This came to a climax with the implementation of the Idukki Hydel project.

But today the picture is dim. Due to various reasons new hydro power projects are not coming up. Irrigation projects are unduly delayed. In many parts of the State there is scarcity of drinking water. Even the capital city is not an exception. Floods and drought continue to work as impediments to the progress of the State.

Looking back we realise that hitherto water resources planning was done 'project wise' without considering the total development of the river basin. Project planning and management has been largely in the hands of Civil Engineers who gave importance to the hydrological, hydraulic and structural aspects of the problem. They focussed more on the dam, regulatory structures, distribution networks etc. Other problems associated with the projects such as agricultural, economic, ecological and social problems caused by drying up of the river, groundwater depletion etc received inadequate attention

But situation has changed. Management of water resources has assumed considerable importance in the context of growing needs and conflicting nature of interests. Therefore planning of water resources of the country will be satisfactory only if the above facts are taken into account, analysed and solutions met with.

AVAILABILITY OF WATER IN INDIA

The prime source of water is precipitation. In India rainfall is generally confined to 3-4 months in a year. Its distribution over the country is highly skew, viz 10 cm in West Rajasthan to over 1100 cm at Cherapunji. Annual variation of rainfal is also highly uneven. Certain assessment of water in India is given in Table 1.

TABLE—1

Surface water potential	—	1780 B.m3
Present consumption	—	310 B.m3

This shows that only 17.4% of the surface water is being used while the rest flows down into the sea often causing disastrous flooding and drainage congestion.

In the opinion of certain experts the country has reached almost midway towards development and use of water resources and this is roughly assessed at 310 B.m3 . The possibility of surface water development may be of the order of 670 B.m3 if the environmental impact assessment do not affect the feasibility of some of the projects. In practice some of the projects have to be dropped on environmental grounds. Some estimates say that even after full potential from surface and ground water is realized, over 55% of surface water would continue to run waste into the sea. These facts point out the need for more effective water resources planning.

USES OF WATER

The main uses of water are the following

1. Rural, Urban and Municipal water supply
2. Irrigation
3. Hydropower development
4. Cooling for thermal/atomic power stations
5. Dilution for pollution control
6. Industrial uses
7. Navigational & recreational uses etc.

PRIORITIES FOR USE

Even though water can be used for a number of purposes it is necessary to fix up priorities for water region wise. A feasible account of priorities is given below:

1. WATER SUPPLY

Water is required for survival of life on our planet. Therefore water supply enjoys highest priority.

2. IRRIGATION

India is essentially an agricultural country. Food production, cash crops and plantations continue to play a major role in the economy of the Nation. This has to be improved with proper irrigation.

3. POWER DEVELOPMENT

Electrification and Industrial development, depend on power development. Several states have no coal reserve. A thermal plant may cause the problem of transportation. A nuclear power station is not likely to be set up in many states where the density of population is high. Therefore hydropower development should be given due priority.

4. FLOODS AND DROUGHT CONTROL

Many parts of the country suffers from cycles of floods and droughts. This form one of the major impediments in the progress of the country.

5. POLLUTION OF RIVERS

Quality of water in rivers has to be improved since this affects the general health of people.

These priorities may change region wise. So also priority once fixed may undergo change in future. In Gujarat several water storage schemes meant for irrigation have been converted to water supply schemes many of them after irrigation benefits started accruing. In Trivandrum during the last drought. (ie. before the Peppara dam was constructed) arrangements were made to divert the water in the Neyyar Dam for drinking purposes. The construction of the Pamba dam under the Sabarigiri Project has practically dried up the Pamba river for a few kilometres below the dam site. This has caused severe water shortage at Triveni during the Sabarimala Pilgrimage season. It need not be mentioned that the water at Triveni is highly polluted during the season.

DEFICIENCIES IN PLANNING OF WATER RESOURCES

The following deficiencies are met with in the planning, design and maintenance of water resource projects.

1. Rainfall and other hydrological data are not adequate
2. Available data in many cases are not dependable
3. Different departments have their own priority of use, without considering the total development of the river basin.
4. Financial and Administrative difficulties cause delay in implementation of the projects.
5. Different agencies are working on different projects in the States. There is no co-ordination of work among them.
6. Assessment of ground water potential is either erroneous or unscientific. About 50% of the tube wells are not functioning according to the design.
7. Performance study of the existing projects are not done. Evaluation of the benefits or defects in planning, execution, maintenance and performance will be guidelines for future work. It is really unfortunate that such repoits are not published.
8. Pollution caused by industries are not effectively tackled.
9. Poor efficiency in water use. Probably the best example is the Trivandrum water supply-There is sufficient storage in the reservoirs but pipelines are empty during day time in summer.

PLANNING FOR FUTURE

In view of the facts stated above it is necessary to reorient the planning of water resources for tomorrow. Planning should be integrated in the sense that the entire water resources available in the basin from the surface as well as from underground should be taken into account. The total water available in the entire river basin and the requirements of water not only for the present needs but also for the projected needs for the foreseeable future period must be considered. Integrated water resources planning aims at the optimal development of water and its use most beneficially under appropriate priorities consistent with the requirements of the region. It is gratifying to note that the guidelines provided by the Ministry of water Resources, Government of India, in the form of "National water policy" projects the need for Integrated water Resources Planning. The following points are worth considering.

1. Establishment of a standardised National information system regarding water resources with a net work of data banks and data bases.

2. Free exchange of data among the various agencies.
3. Planning of Water resources strictly "Basin wise" for a hydrological unit as a whole.
4. Preparation of a Master plan for each hydrologic unit such as a river basin or aquifer.
5. Consideration of individual development proposal only within the framework of such an overall plan for a basin.
6. Establishment of appropriate organisations for the planned development and management of a river basin as a whole.
7. Evaluating the possibility of developing each water resources project as a multipurpose project.
8. Integrated and coordinated development of surface water and groundwater and their conjunctive use.
9. Preservation of quality of environmental and ecological balance.
10. Considering the impact of project on human lives, settlements and occupations as an essential component of planning.
11. Organisational set up to review the safety of storage dams and other water-related structures.
12. Periodical reassessment of ground water potential.
13. Regulation of ground water exploitation within the recharging possibilities.
14. Absolute prevention of over exploitation of ground water near coastal tracts.
15. Integration of water-use and land-use policies.
16. Full utilisation of Irrigation potential created.
17. Regularity in monitoring of surface water and ground water quality.
18. Phased programmes to improve water quality.
19. Minimisation of erosion of land by river and sea.
20. Rehabilitation of effected people.
21. Improved water management and modernization of existing water projects.
22. Starting new surface water projects.
23. Water-Balance study of various river basins and sub-basins.
24. Detection of new ground water sources using modern technology such as satellite imagery, Aerial surveying, Remote sensing etc.
25. Remodelling of old schemes to create new benefits.
26. Study of water requirements of crops and field irrigation methods.
27. Improved control of hydraulic structures, sluices, valves etc.
28. Adequate maintenance.
29. Evaluation of project performance in terms of water use, crops irrigated, agricultural produce and farmers participation.
30. Soil conservation.
31. Study of reservior silting and life of reserviors.
32. Detailed soil investigation and land use.
33. Proper assessment of water quality.
34. Educating citizens and farmers about optimum utilization of water.
35. Improved irrigation system such as sprinkler irrigation, drip irrigation.
36. Use of High-Tech applications such as Computer Programming, hydrological modelling, ground water modelling, finite element analysis etc.
37. Artificial recharge of underground storages by diverting flood water.
38. Construction of check dams to improve ground water storage.
39. Maximum efficiency in water use.

40. Catchment treatment and command area development.

41. Recycling and reuse of water.

42. Study of evaporation and seepage losses.

43. Preparation of master plan for flood control and management of each flood prone basin.

44. Efficient network of flood forecasting.

45. Assigning priority for the needs of drought-prone areas

46. Rationalisation of tariffs for drinking and irrigation water supplies.

47. Forecasting droughts and planning to face it.

48. Early settlement of disputes regarding inter-state rivers.

49. Inter basin transfer of water based on a National water plan.

50. Promotion of research and development activities in water resources.

51. Mass awareness programmes to consider water as "Scarce material" a "divine gift" and "wealth of the Nation".

NECESSITY OF IMPLEMENTATION OF NATIONAL WATER POLICY

In keeping with the objectives of the International Drinking water supply and sanitation Decade Programme (1981-1991) adequate drinking water facilities should be provided to the entire population both in urban and in rural areas by 1991. Irrigation and multipurpose projects should invariably include a drinking water component, wherever there is no alternative source for drinking water. Drinking water needs of human beings and animals should be the first charge on any available water.

In view of the vital importance of water for human life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resources and its optimal, economical and equitable use has become a matter of the utmost urgency. Therefore National water policy should be implemented at the earliest.

CONCLUSION

Sweeping changes are occuring all over the world in Science, Engineering and Technology. The growth of our country depends upon how fast we absorb new concepts, processes and devices and synchronize ourselves with the development of the outside world. It is time to reassess the water wealth of the country and project the need of integrated planning aiming at optimum and efficient utilization of the same for the benefit of the entire Nation. □

MONITORING:

Monitoring by itself does not solve problems; but it renders possible, timely identification of problems and a realistic evaluation of alternating methods of corrective action. Functional requirements of monitoring systems are:

(a) Capacity to generate standardised information
(b) Well devised but simplified format for easy use
(c) Processed data should be relevent and useful for decision-making besides forming reliable data base
(d) System should be simple and not a burden on the project team.

Financing & Management of Water Supply Schemes. State of Urban Water Supply in Bihar

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Water Supply has become a critical factor in public health and economic development in most parts of the world, particularly in the developing countries.

Adequate potable water supply and waste and sewage disposal are the basic needs for the growth, development and sustenance of human society.

The United Nations, in 1980, declared 1981-90 as the "International Drinking Water and Sanitation Decade", India, a signatory to the U. N. Resolution, is committed to the goal of providing safe drinking water and adequate sanitation to all its citizens. The Decade programme was launched in this country on the 1st April 1981 and will continue upto 31st March 1991, covering the last four years of the Sixth Five Year Plan (1980-85), all five years of Seventh Plan (1985-90) and the first year of the Eighth Plan. The targets set to be achieved during the Decade in respect of both Urban and Rural Water Supply were 100% coverage of population. At the begining of the decade, about 72.3% of Urban Population and 31% of rural population in India had been provided with protected drinking water supply facilities. Comparative figures for Bihar were 63.4% & 68.5% respectively.

Even though the Decade programme was launched in India in right earnest, reduced outlays in the Seventh Plan put great constraint on resources. A mid-term review was carried out by the Government of India in October 1985 and after detailed appraisal of progress and resource constraints it was decided to reduce the achievement targets. Accordingly revised targets for Urban and Rural Water Supply were fixed at 90% & 85% respectively. The coverages achieved in the country as of 1985 were 72.9% & 56.2% and in Bihar 59.5% & 77.8% respectively. This state, thus, had a negative progress (—3.9%) in Urban Water Supply which is a cause for concern.

The mid-decade review, besides setting new targets, received some valuable suggestions regarding some important aspects for implementation and operation of Water Supply Schemes, especially in Urban Sector. Generating finance for Urban Water Supply and Sanitation, which falls under the State Government Sector, has been the greatest constraint for achieving any target.

In view of above, suggestions, were put forward during the mid-term review for setting up a Centrally-Sponsored programme for Urban Water Supply on the lines of the Accelerated Rural Water Supply Programme, especially for small towns having a population of 20,000 or less. It was also suggested that Urban drinking Water Supply should be included in the Minimum Needs Programme. The other important suggestions were special allocation of fund by Government of India for the towns in Tribal areas/hilly areas for water supply and review of tariff structure, billing cycle and collection efficiency of local bodies/water supply authorities.

In view of the rapid growth in urban population and the consequent pressure on civic amenities,

especially Water Supply, the adoption and implementation of the suggestions regarding funding of Urban Project by the Government of India, will greatly help in improving Water Supply in our cities and towns. This must have to be taken as a socio-eco-nomic necessity. The difference in coverage of Urban and Rural Water Supply between 1981-85, as per mid-Decade appraisal is + 0.6% and + 25.4% respectively, which, in itself, is a sad commentary on the state Urban Water Supply.

I shall now deal with the state of Urban Water Supply in Bihar, with particular emphasis on Operation and Maintenance, which is one of the topics of discussion of this Seminar.

Bihar covers about 5.30 percent of the Indian territory and ranks second to Uttar Pradesh in population, having about 10.5% of the entire population of the country. Out of its total population of 69.92 millions as per 1981 census, 61.20 live in rural areas and the rest 8.72 million in urban areas. The state is endowed with abundant ground & surface water resources. Quality of water, in general, is acceptable except that the ground water in the districts of Purnea, Katihar and parts of adjoining districts have excessive concentration of dissolved iron.

During pre-independence days the subject of Health was transferred by Central Governments to Provincial Governments, who, in turn, transferred it to local bodies. During this period, only a few local bodies succeeded in prevailing upon the Govt. to instal water supply systems in towns. Wherever installed, these systems were run without perceptible improvement, and were, therefore, unable to meet growing demands.

After independence and adoption of Constitution, Water Supply and Sanitation was classified as State Subjects. The responsibility of developing this sector, therefore, devolved upon the State Govt., which executed them through Departments of the Government and through Local Bodies which were delegated with duties & responsibilities through enactments or by executive orders. Provision of Water Supply and Sanitation is the obligatory function of the Local Bodies.

The State Government has been making efforts to provide water supply and sanitation in the urban areas, since 1947 within available resources. But the shift of priority from urban to rural sector will be amply clear from the abstract of Plan Outlays since 1951 as presented below:-

(Outlay—Rupees in Crores. One Crore = 10 millions).

Period	Total Plan Outlay of the State	Total Plan Outlay on W/S & Sanitation		Outlay on Urban W/S and Sanitation		Outlay on Rural Water Supply & Sanitation	
		Amount	% of total Plan Outlay	Amount	% of total Plan Outlay	Amount	% of total Plan Outlay
1	2	3	4	5	6	7	8
1st Plan (1951-56)	73.38	4.21	5.73	1.97	2.68	2.24	3.05
2nd Plan (1956-61)	177.98	3.38	3.58	1.33	2.43	2.05	1.15
3rd Plan (1961-66)	331.95	3.86	3.09	2.74	0.74	1.12	0.35

1	2	3	4	5	6	7	8
Annual Plans (1966-69)	217.37	1.80	0.82	0.25	0.12	1.55	0.70
4th Plan (1969-74)	485.60	10.20	2.12	3.70	0.75	6.50	1.37
5th Plan (1974-78)	1267.60	28.65	1.80	9.52	0.75	19.13	1.13
Annual Plans (1978-80)	719.37	36.50	5.08	3.90	0.55	32.60	4.53
6th Plan (1980-85)	3255.00	100.14	3.10	25.14	0.78	75.00	2.32
7th Plan (1985-90)	5100.00	179.00	3.50	65.30	1.28	113.70	2.22

Considering the meagre outlays for Urban Water Supply and Sanitation, achievement of goals set for the decade is much beyond the financial capabilities of the State. This also brings in focus the need for Central Government grants for Urban Water Supply.

In Bihar, the Urban Development Department is administratively responsible for Urban Water Supply and Sanitation. Other agencies involved in the administration of the Water Supply and Sanitation Sector include:–

(i) Planning Department - which is responsible for co-ordinating planning in all sectors including Water Supply & Sanitation.

(ii) Water Pollution Control Board for implementing Pollution Control programme.

(iii) Public Health Laboratory - for quality control.

(iv) Jal Parshad (Water and Sewage Board) executes the projects under the Ganga Action Plan.

The P. H. E. D., headed by Engineer-in-Chief and consisting of a strong contingent of technical and non-technical personnel, executes projects for the Urban Development Department, as an agency and operate and maintain most of the Water Supply Schemes on behalf of local bodies.

The existing pattern of funding of Urban Schemes is 25% of the estimated cost as grants-in-aid and the balance 75% as loan. The alloted fund for the particular schemes is given to the concerned Municipality or Corporation to be transfered to the respective Executive Engineer. This method of transfer of fund is a big damper for timely completion of schemes as most of the municipal bodies do not transfer the funds promptly and, not infrequently, over long periods. This mode of transfer of funds needs to be reviewed and preferrably revised.

Another constraint is the inadequate yearly allocation, which, naturally, delays the scheme resulting in escalation of cost. This is the primary reason why most of the schemes have to be revised, and time schedule for completion cannot be maintained.

That an outright 100% Govt. grant alloted directly to P. H. E. D., is helpful in timely completion and commissioning of a scheme, is best demonstr-

ated in the execution of 37.5 M G.D. Swarnarekha Water Supply Scheme and the 10 M G D. Hatia Water Supply Scheme, both at Ranchi. Swarnarckha Water Supply Scheme is one of the biggest Schemes in Eastern India.

Out of 220 cities and towns in the state (as per 1981 census) 179 are provided with piped water supply. Rest 41 are served by Hand or Drilled tube-wells. Even in towns, where piped water supply is already available, some parts are still uncovered. The bigger cities are growing at a faster rate mostly due to migration of people from rural areas in search of employment. All the piped water supply schemes are run by electricity. In all the towns, the supply is intermittent and is made for 4-16 hours per day depending upon the various constraints in each town but mainly upon the availability of electricity.

As we have already discussed, the single most important constraint in achieving the decade goal has been inadequate financial resources. This is equally applicable in case of Operation and Maintenance of the existing systems. It is imperative, therefore, that the assets created are operated and maintained in a way so that there is no deterioration of the system. This, in itself, will save scarce resources, and also provide the public with better quality of water.

In Bihar, all the town water supply schemes except of Patna, Muzaffarpur, Arrah, Monghyr and Bhagalpur, are maintained by P. H. E. D. The local bodies, mostly, do not have trained technical personnel and in any case, they are reluctant to take over the responsibility. Budget provisions are, therefore, made annually under non-plan head for repair and maintenance funds. The budget provision for 1990-91 is 1345.80 lakhs. Actual allotment of fund, nevertheless, is much less almost in every financial year.

During the mid-term review of the Decade programme, the consensus of discussion was that while the water sources should be maintaincd by the State Agencies, the distribution network should be maintained by local bodies. This has not so far been possible in Bihar, because the local bodies are neither financially nor technically competent for such take over, nor are they keen to take over such responsibilities.

It is necessary that a water supply system should generate funds to meet the annual maintenance cost. But, in Bihar, as in probably most of other States, water supply is considered as a welfare measure and any idea, therefore of levying increased water tariff is opposed. The idea of commercialisation of water supply doesnot apply.

The participants in the mid-Decade survey clearly stressed that water supply schemes cannot be self-supporting as tariff cannot be raised to a level sufficient to cover operation and maintenance cost. That tariff should be raised to cover even debt services was unrealistic. It was, therefore, necessary to extend financial assistance, for operation and maintenance. For the present it is more realistic to ensure effective collection of taxes and to evolve ways for their transfer to P. H. E. D. by the local bodies, which otherwise divert whatever taxes are collected. Public awareness is also being created for payment of taxes which will, in turn, help render more effective Public Service.

Metered connections are not in vogue in the state. It may not be helpful either because the quantity of water produced and quantity recorded in meters in individual household and establishments may have substantial difference owing to loss due to leakage or theft of water inbetween source and point of supply. Another drawback of metered connection is the maintenance of meters which is the obligation of the owner of the holding. For the present, quantity of supply is computed on the basis of supply hours.

Substantial Water tariff, realised by the P.H.E.D. for bulk supply to industries and other establishments in the Industrial Towns of Ranchi & Jamshedpur are deposited as state revenue. This cannot, therefore, be utilised towards the operation and maintenance of these schemes, which could otherwise be of great help.

Considering the above constraints, Operation and maintenance is wholly dependent on allotment of fund by the state Government, howsoever meagre it might be.

Most of the Urban Water Schemes in North and in parts of Central Bihar use ground water as source, which, naturally, is easier to operate and maintain. South Bihar is entirely dependent on surface water source, which entails costly treatment procedure. Considering the potentiality of pollution of such sources, especially in industrial belts, regular water sample tests are conducted in

On the whole, the operation and maintenance of Water Supply System in Bihar cannot be said to be in a very happy situation, mainly because of resource constraints. We are taking steps to gear up supervision through training programme of the staff. For this it is proposed to open a training institute at Ranchi in future. Necessary proposal has already been submitted for including in the eighth plan.

I have based my observations in this paper mostly on our experience in respect of execution, operation and maintenance of Urban Water Supply Schemes in Bihar and on various study papers on the subject. Some of the problems, especially resource mobilisation, may be common to other states also. It is my considered opinion that Urban Water Supply cannot be left to its own fate and in a state of neglect as of now, while rate of urban population growth is rapidly increasing. Various committees and Seminars sponsored by the Central Govt. from time to time, non-Governmental agencies and more specially the Conference held at New Delhi in October 1985 to review the mid-Decade progress, have made important and viable suggestions and recommendations almost on all aspects of Urban Water Supply. Based on them and on our own experience in our State, I would like to make the following suggestions to make urban water supply cost effective, viable and Socio-economically beneficial in the long run:-

* Urban Water Supply Programme should be centrally sponsored Programme like A. R. P. for towns with a population of 2 lakh and less. As suggested during the Ministers' Conference in 1985, a sperate financial institution for Water Supply should be set up immediately to ensure flow of funds in this sector. It may be designated as National Urban Water and Sanitation Bank.

* Considering the hike in wages and rise in cost of materials, operation and maintenance, urban water supply schemes will also need Central assistance for O & M on the lines of the assistance given by the Central Govt. for the maintenance of the assets created under ARP programme.

* The present system of routing of funds through Local Bodies should be abolished by amending the Municipal Act, if necessary. This will, to a great extent, avoid delay and cost escalation. The grants-in-aid given by the State Govt. as in Bihar, at present, should be given directly to the executing agency.

* The most equitable method of collection of Water tariff will be to meter all connections. But in States, such as in Bihar, where metering is not in practice, flat rate, which is the simplest form of water rate, may be imposed with the rider that the agency maintaining and operating the scheme should collect the tariff. The flat rate should be computed on the basis of current water rate, average hours of supply per day, and number of connections, fixtures, and bulk storage arrangements in a holding. Flat rates should be revised every two years on the basis of revised Water rates.

* Phased introduction of Management Information System (M.I.S.) starting from bigger schemes, for effective planning, monitoring, control and operational functions. In this regard, the report submitted to the Ministry of Urban Development, Govt. of India, in August 1988 by the Pilot Project Team on M.I.S. for Urban Water Supply and Sanitation, should be of relevance.

* Leak detection and minimising wastage of water is vital to any water supply system and should be given immediate attention. Studies have revealed that 17-44% of total flow into a distribution system is lost through leakages. Moreover, in cities and towns where supply is intermittent, leakages lead to contamination of water supply. Every water works should, therefore, have a Leak - Detection and Wastage Prevention Cell manned by trained personnel and provided with necessary equipments.

* Effective management of wastage prevention may even make it unnecessary to take up immediate augmentation schemes of any existing water supply system.

* A continuing programme of training for professional and semi-professional personnel at all levels to update knowledge and efficiency. Such training institutes should be set up in every State and allocation of funds in the budget for training programmes should be mandatory.

* For strict quality control every urban water works should have a well equipped laboratory manned by qualified staff. Frequent chemical and bacteriological test of water, particularly in case of surface source, will ensure safety of the water supplied, and minimise cost of production by fixing optimum chemical dosing.

* In State where power position is uncertain, dispersed sources at suitable locations in every town is an unavoidable necessity. The Ministry of Urban Development, Government of India should allot funds for this programme like ARP programme.

* Most of the water works depend on power supply, which should, therefore, be made available at concessional rates.

* Public awareness should be generated towards prevention of wastage and theft of water and regarding the necessity of paying water tariff regularly. This should be done with the help of audio-visual and print media.

* Urban Water Supply should be treated in Priority Sector and special feeder line for power supply should be provided for water supply installations. The cost will form a part of the original scheme.

* Finance Commission may be requested to recommend suitable allocation of fund for O & M of urban water supply systems under Non-Plan budget head.

□

1 Learn all the rules, every one of them so that you will know how to break them.
2 Only a life lived for others is a life worthwhile.
3 It is better to be lucky than wise.
4 It is much easier to be critical than to be correct.
5 The trouble about man is twofold. He cannot learn truths which are too complicated; he forgets truths which are too simple.
6 Falsehoods not only disagree with truths, but usually quarrel among themselves.
7 We have no more rights to consume happiness without producing it than to consume wealth without producing it.
8 To be poor and independent is very near impossibility.
9 One of the greatest pains to human nature is the pain of a new idea.
10 What you have inherited from your fathers' you must earn in order to possess.
11 It does not take a majority to make a rebellion; it takes only a few determined leaders and a sound cause.
12 You cannot always build the future for your youth, but we can build our youth for the future.
13 Whenever there is a conflict between human rights and property rights, human rights must prevail.
14 Lack of money is the root of all evil.
15 Laws too gentle are seldom obeyed; too severe seldom executed.
16 Fear can keep a man out of danger; but courage only can help him in it.
17 You have not converted a man because you have silenced him.

Quotations compiled by Sri. B. Bijli.

Financing and Management Of Water Supply

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INTRODUCTION

The Water Supply Finances generally depends upon the following:

1 The Capital cost required for the installation of the system.

2 The Revenue required to meet the Annual expenses including fixing of Tariffs and its collection.

3 The usage of Revenue derived from Revenue Collections

4 Financial Organisation and its control

A good management of Water Supply System depends on number of items such as

1 Provision for proper perfect maintenance of the Scheme

2 Smooth performance of the Scheme.

3 Good economical maintenance of the Scheme.

4 Efficient Administration.

5 Preventive measures for arresting wastages in Water Supply.

6 Public participation in execution and maintenance of the Scheme.

The successful management involves:

1 A detailed knowledge of the system, the basis adopted for designs.

2 The various charts which indicate the details of work and time schedules.

3 The powers and duties and responsibilities of the Staff in the organisation for routine maintenance.

4 To carry out Health Education Programmes to get full Co-operation from Public.

A water supply organisation should be treated as a Business enterprise involving management skills and Engineering knowledge to make the scheme successful and safe in practice and also in financial considerations.

For safe and proper quality of water supply, which should be prime consideration of the organisation, it is desirable to head the management from a highly qualified Public Health Engineer.

The aim of any water supply undertaking must be to provide wholesome and adequate supplies of water at the lowest practicable cost. To achieve this, it may be necessary to have equal spreading of the cost of water supply by means of appropriate scales for charges for a public water supply rate. The transactions of finances in any water scheme can be generally classified into two classes namely Capital cost and Revenue. The Capital cost is the amount invested in water supply undertaking from the beginning of taking up the scheme to the time the scheme is placed under operation. Revenue denotes the income after completion of the scheme, mostly from water supply charges. Therefore, the financial status of any water supply scheme

will mostly deal with the estimated cost of production of water supply of a particular scheme.

Any water supply scheme has to be planned, designed and executed and maintained under the target of "No Profit-No Loss Basis". To achieve this goal, it is necessary to have the cost of production of water supply of a scheme not high enough to fetch more revenue after completion of the scheme and discourage the consumers from making use of sale of water. The cost of production of water supply should be such as to make the scheme "self paying and self maintaining". Therefore, it is desirable to observe certain economy measures in production cost of water supply of a scheme so that the Revenue that is obtained from sale of water can be utilised for maintaining the scheme. The production cost of water supply of a scheme generally depends upon the following various components.

Identification of sources - Alternative Sources
Water quality Maps - Preparations
Treatment process
Conveyance and supplies of water
Chemicals - Disinfection and its Techniques
Laboratory and its Equipments
Cost of Electricity in Supply and Maintenance of Drinking Water
Annual operation and Maintenance charges
Preventive Maintenance - Leakage - Detection
Monitoring - Standardisation
The Tariff to be fixed for sale of water and
Method of Finances.

IDENTIFICATION OF SOURCES - ALTERNATIVE SOURCES

SURFACE WATER

The surface water such as Natural Quiescent waters as in lakes and ponds would be more uniform in quality than water from flowing streams. Long storage permits sedimentation of suspended matter, bleaching of colour, Self purification which is an inherent property of water to purify itself is usually less complete in lakes. If the catchment is protected and unerodable, the stored water may not require any treatment other than disinfection.

The Artificial Quiescent waters such as impounding Reservoirs formed by hydraulic structures across river valleys are subjected more or less to the same conditions as natural lakes and ponds.

GROUND WATERS

Rainwater percolating into the ground and escaping beyond the reach of vegetation and either collecting in underground basins or flowing underground in sub-surface streams, constitutes a ground water source. The water as it seeps down, comes in contact with organic and inorganic substances during its passage through the ground and acquires chemical characteristics representative of the strata it passes through.

Generally ground waters are clear and colourless but are harder than the surface waters of the Region in which they occur. Ground Waters are generally of uniform quality although changes may occur in the quality with changes in the strata. Thus the estimated cost of the scheme can be economically worked based on the availability and dependability of proper resources for any project of water supply scheme. This will inturn reduce the production cost of water.

In advanced countries where Finance constraints are not there, two reliable sources usually will be selected duly laying emergency lines to meet the immediate requirements in case of failure of a source. This aspect may not be possible in all situations due to financial restrictions. The otherway of achieving the uninterrupted Water Supply is only by selecting a source of 100% reliability while selecting the source. This can be achieved only by collecting data and records for a long period.

WATER QUALITY MAPS-PREPARATION

In view of the necessity of maintaining the good quality of drinking water, the possible sources of augmenting the water supply, proportionate to growth of populations also are to be examined. It is desirable to examine the various sources of surface water from major rivers and ground waters if any nearby, the locality and merits and de-merits of each alternative should be studied in detail.

Based on these investigations, water quality maps can be prepared to show the general quality

and available quantity of water. The dependability of source can also be defined from the records collected for a long period. Financial assistance either National or International is necessary for the preparation of water quality maps of the resources in general and also to the institute of preventive medicine to prepare the maps showing the areas of high flouride incidence and other harmful chemicals. Taking guidance from these maps, the specific sources selected for the water supply and the capital outlay of the scheme can be arrived economically by making Comparative Statements of all the alternatives and sources available. By taking up detailed studies of water quality maps the specific quality problems and standardisation in water supply scheme can also be solved.

From Water quality maps, a Master Plan can be prepared depicting the requirement of drinking water and the sources of supply available. The data collected from these maps could be made use to Co - ordinate and advise on the steps to be taken to ensure that the water of the Right quality is made available to the people.

Government can form " Apex Bodies " consisting of experts from various institutions and also Retired Engineers to prepare these water quality maps which can effectively execute the project in time without missing all the possible alternate sources available nearby in a limited time for the preparation of Water Supply Scheme.

TREATMENT PROCESS

Based on the quality of raw water available, the Engineering Works for the preconditioning of the water and desired standards of water quality, final treatment would be decided on an adhoc basis and the cost involved worked out to a close approximation. The best location for the treatment plant with reference to the source and project area to be served would also need to be decided upon to secure maximum economy, utility and operational efficiency. Generally the treatment plant should be located as nearer to the Head Works as possible. In the treatment plant, the water is to be analysed at each stage in the treatment units so as to know the efficiency of performance of different units as well as to determine the optimum dosage of the chemicals to be applied. Though the treatment of water would achieve the desired quality, the evaluation of its quality should not be confined to the end of the treatment facilities but should be extended to the point of consumer use.

The treatment plant must also be free from water logging and location may be done from availability of Hard Soils at comparatively shallow depths. It should have provision for future expansion. Thus location of treatment plant and the correct planning of treatment process influence to a great extent on the estimated cost of the scheme and in turn the production cost.

CONVEYANCE AND SUPPLIES OF WATER

The most satisfactory alignment of the conveying main should be decided after a proper study of the available contour plans and topo sheets, supplemented by a site survey and collection of additional field data and levels as may be necessary to avoid any unrealistic assessment of work. The transmission of water from the source to the area of consumption is one of the most important items in a water supply scheme. Depending upon the topography and local conditions, conveyance may be in gravity flow or pumping main.

Transmission of water accounts for an appreciable part of the capital outlay and hence careful considerations of the economic size as well as the type of material used for pipe is called for before deciding on the best mode of conveyance. While water is being conveyed, it is necessary to ensure that there is no possibility of pollution from surrounding areas. When the source is separated by a long distance from the Town, the conveyance of water over the distance involves the provision of a pressure pipe line or a free flow conduct entailing an appreciable capital outlay. The most economical arrangement for the conveyance is therefore plays an important role in a Water Supply Scheme.

CHEMICALS-DISINFECTIONS AND ITS TECHNIQUES

The chemicals are introduced into the water for the purpose of coagulation and flocculation, disinfection, softening, corrosion control, algae control and fluoridation. In general chemicals are used as solutions or liquid suspensions. As the treatment process is continuous, the flow of chemicals is regulated and measured continuously through chemical feeders which can be either solution feed

type or the dry feed type. The installation of chemical feeders obviously promote the uniform distribution of chemicals and eliminates wastage. A knowledge of the solubility characteristics of the chemicals as well as the solution strength that are used in normal practice will facilitate the choice of feed equipment.

A reasonable cost of these chemicals permitting accurate application to water reduces considerably the production cost of drinking water. The chemicals that are used should be stored in a damp proof construction properly drained. Special precautions in storing chemicals should be taken by providing sufficient space with access for handling bulk storages.

Chemicals such as salts of aluminium i.e., Alum are utilised asbest coagulants. Small Scale Industries which are aided by Government can be exclusively encouraged for a major water supply scheme for the manufacture and supply of coagulants such as Alum, Silica, Bleaching powder etc., regularly so as to eliminate wastage of time and to have the control over the quality as well as on the cost of the same, thereby bringing down the estimated cost and inturn production cost.

To provide safe water, it is necessary to disinfect the water to destroy all the disease producing organisms, since the raw water resources are becoming increasingly prone to pollution. Boiling water is one of the simple methods for destruction of bacteria to some extent. However, chemicals such as chlorine and its compounds, bromine, iodine, potassium permangenate, ozone etc., has been under use as effective disinfectants.

The chemicals that are generally used should be capable of destroying pathogenic organisms present in water within the contact time available and should not leave products of reaction which render the water toxic or make it unpotable. The chemicals should be readily available at a very reasonable cost permitting accurate application to water. The efficiency of disinfection will obviously depend on the nature of the disinfectant used.

Chlorine by virtue of its oxidising power can be consumed by organic materials before any disinfection is achieved. The chlorine demand of any given water varies with the amount of chlorine applied to the time of contact, PH value and its temperature. Chlorine can be easily applied by the addition of weak solutions prepared from bleaching powder in small public water supplies. Chlorine can be applied by the addition of chlorine either in gaseous form or in the form of a solution made by dissolving gaseous chlorine obtained through cylinders containing gas, under pressure.

Only trained personnel should be permitted to handle chlorine cylinders and chlorinating equipment to avoid dangers and wastages. By proper advance planning for continuous and regular supply and continuous in usage of disinfectants duly encouraging some Small Scale Industries it is possible to bring down the production cost of water before it is supplied to the consumer.

LABORATORY AND ITS EQUIPMENTS

Laboratories with adequate facilities and manned by qualified personnel are essential for regular inspection and evaluation of the suitability of water supplies for public use as well as for controlling the water treatment processes. The ultimate aim of laboratory examination of water is to ensure that potable water conforming to the drinking water standards is supplied to the consumers. Tests carried out in the Laboratory are intended to assess the quality and classify the raw water to be treated, to determine the need and extent of treatment and to ensure that the water conforms to the standards. Laboratory facilities are thus indispensable for controlling plant operations and to record and to improve plant performance which help research and development. The Laboratory examination comprises of Physical, Chemical, Bacteriological and Biological analysis. The value of any laboratory analysis and test depends upon the method of sampling. The schedule of laboratory tests followed by a particular undertaking will vary with the size of the plant and character of water treated.

Therefore, a well equipped laboratory is a must for efficient analytical control. The size and equipment of the laboratory depends more upon the nature of the processes to be controlled and to a lesser extent on the size of the plant. The laboratory could be divided into several units namely physical laboratory, chemical laboratory, bacteriological laboratory, and biological laboratory. For small plants, all units can be combined into one laboratory.

It is therefore necessary that any Water Supply Project should be provided with well equipped laboratories and facilities for minimising various losses. The equipment in the laboratories must be adequate to permit proper analysis and proper control over purification processes. Therefore, careful planning is a must for proper maintenance of equipments and storage of chemicals to be used for tests. The equipments should be frequently checked for standards. Efficient and effective management of these laboratories can make supply of water to the desired standards and at a very low cost of production. It is generally observed that the establishing of these laboratories are neglected due to various reasons mainly due to lack of finances. Hence, it is desirable to encourage various private bodies which can be financed by lending institutions for establishing the laboratories for eftective management of schemes.

UNINTERRUPTED POWER SUPPLY AND ITS ECONOMY

Electricity is the next major raw material to water. Depending upon the project, the Capital cost of Electricity varies from 10 to 30%. In maintenance, the supply and maintenance cost of Unit drinking water has electricity as a major component. About 60% of unit cost is towards Electricity. The cost of Electricity is dependent on the policies of local Electricity undertakings.

Hitherto projects envisaging water to Agricultural and generating Electricity are called multipurpose projects. In addition to the above two requirements, water is being contemplated to use for drinking purpose. A real multipurpose project should have all the three functions. Out of the total developed power, if a portion, say 20% is ear-marked for drinking water, the production cost of water supply will be very nominal. All the three i. e., Electricity, Irrigation & Drinking Water Projects are takenup by Government or Public Sector with public finances. Taking advantage by one sector, say Electricity undertaking to cater the needs of another sector say Water Supply undertaking is against the norms of national policies. The Electrical undertaking should not view the water supply undertaking from commercial point of view when basically both are financed through common resources. The power can be taken by water supply undertakings through the separate lines. The unit cost of generation that is appropriately apportioned to the power made available together with cost of transmission losses can be chargeable to water supply undertakings, and the cost in any case will be less than 75% of the usual cost.

The Water Supply undertakings can think of its own captive power without depending on Electricity Supply undertakings fully. Small solar batteries can be installed and many small Pumping Stations less than 1 M V A can be operated on these batteries. There is no maintenance cost practically. The units, of course, may not run on rainy or cloudy days, at which times the standbye power supply can be utilised by means of providing generators.

The major contribution towards cost of Electricity in the unit cost of water supplied is due to improper maintenance of Electrical equipment. Only breakdown maintenance is attended in water supply undertakings and preventive maintenance is not given importance. The motors are stopped only when they fail. The breakers and t ransformers are put off only after their failure. If preventive maintenance is carried effectively, the frequent failure of Electrical equipment could be avoided. If the preventive maintenance is properly attended, 20% of unit cost can be reduced and supply of water can be maintained un-interruptedly. To have uninterrupted water supply, it is desirable to have two Reliable and dependable sources, one being kept as stand-bye with all latest remote controls.

ANNUAL OPERATION AND MAINTENANCE CHARGES

Annual recurring charges on energy and operations and maintenance are a perpetuity, irrespective of the design period or the life of the Pipeline. The capitalised value is restricted to the design period or the loan repayment period whichever is greater.

In order to keep the entire project equipment and plant, structures, in optimum working order, it is necessary to have the perfect maintenance of the project itself. The maintenance should be carried out in a manner which prevents emergencies and unscheduled breakdowns.

Basically any maintenance programme should establish:

1 A system plan of daily operations

2 A routine schedule for inspection of Machinery & Plant

3 A record of analysis of water collected at various points from the sources to the distribution system and observation on the effect of such quality on the several units of operation.

4 To list out various safety measures and take effective precautionary measures to ensure effective operation and maintenance of Water Supply System.

Keeping in view the importance of Water Supply System, due priority should be given by alloting necessary funds for achieving the envisaged targets.

The other important factors in operation and maintenance of the water supply system are periodical leak detection and preventive maintenance activities. In this regard leak detection and preventive maintenance cells may be provided for the personnel involved in this activity. Health education programmes should be initiated and monitor the progress of various schemes for better management of all activities. Also in order to achieve the envisaged targets, adequate and qualified manpower should be appointed by Government and R & D cells may be set up to study various aspects including production cost and delivery of water to the consumers.

PREVENTIVE MAINTENANCE - LEAKAGE DETECTION

Preventive maintenance of water distribution system in pipe lines assures the twin objectives of preserving the hygienic quality of water in the distribution mains and avoids wastage in distribution. The main functions in the management of the preventive aspects in the maintenance of mains are assessment, detection and prevention of pollution and maintaining the capacities of Pipe lines thereby increasing the life of the Pipelines.

A systematic waste and leakage survey and detection, followed by prompt corrective action is of importance in bringing about a reduction in the wastage. The frequency and extent of the survey depends on the cost and the net benefits accruing therefrom The approach of the problems for waste survey procedure requires careful planning and preparatory work and a large amount of routine field survey and investigation.

Leakage detection survey can be confined only to the areas of heavy leakages as arrived at by the waste assessment survey of

a) finding leaks in the pipes by visual examinations of surface.

b) by the use of 'sounding rod' or electronic leak locator for pin pointing of leaks in pipes.

c) each locality can be separated to arrive at the actual quantity of water supplied to that area of distribution and compare the same with the billing system. If the difference is not within the reasonable percentage i. e., between 10 to 15%, the precautionary measures should be taken to find out the wastages and illegal connections.

The use of electronic pipe locator (detector) can expedite the location of buried pipes. In the case of 'Sounding Rods' the sound generated by the leaks through the over burden is picked by the ear through these sounding rods and locates leaks in pipes.

Since maintenance techniques are constantly changing and new methods, new special tools and new materials are being developed to improve efficiency, group discussions, and group lectures on various techniques of preventive measures will enable the maintenance staff to widen their knowledge of the subject and thus these preventive measures helps to locate potential sources of trouble and goes a long way to avoid many breakdowns and remedial measures can be positively taken up to prevent all losses in any water supply scheme. This will reduce the maintenance cost considerably thereby reducing the production cost.

MONITORING - STANDARDISATION

"Apove Ithagam Sarvam" says in Rigveda which means "Water is everything the water only is everything". Due to lack of safe drinking water, much ill health is being caused. Millions of people particularly children die due to many water borne and water related diseases like Cholera, Typhoid, Dysentry, Diarrhoea, Jaundice, Hepatitis, Malaria, Filaria, Guineaworm and Brainfever. The wealth of the nation is known seeing the health of its people. Crores and crores of rupees are being spent year after year as a recurring expenditure on the medical care for water borne and allied diseases. "Prevention is better than cure". As such, pre-requisite for health and comfortable living is nothing but the provision of safe and adequate drinking water supply and hygienic disposal of waste waters.

Thus the importance of establishing an effective sampling and monitoring programme needs no emphasis. Certain chemical substances present in natural water such as flourides, nitrates metallic ions maybe toxic or injurious to health depending on concentration. They should not be permitted in excess of permissible concentration. Some other substances may render the water unfit for use for various domestic purposes (washing, cleaning etc.,). For these substances the highest desirable and maximum allowable concentrations are prescribed taking into account the amount normally acceptable to the consumers and the maximum permissible in the absence of better source. It is not out of place to mention, that presence of certain minerals or salts in minimum quantities in water are essential.

Technology should run on socio-economic conditions of the people. This is true in the case of implementation of water supply and sanitation schemes. While formulating a water supply scheme, community participation can be sought in several matters including water timings and location of public stand posts. The fact remains that when the local people are consulted, they develop a feeling of pride in the scheme which will reap rich dividends as people will not only help in the proper maintenance but also in preventing the vandalism which is so common in water supply installations both in urban and rural areas. The experience shows where the local conditions were not considered and the prospective beneficiaries not consulted, water supply and sanitation schemes have often fallen into disuse.

It is not enough to provide safe protected water supply system in the rural areas, but, the people, particularly women should be educated how to collect the water, carry it home and store it properly avoiding contamination of the water till it is actually consumed. Simple education is needed to avoid the risks of contamination of water before it is actually consumed by the members of the family. Therefore health education is necessary in addition to community participation.

METHOD OF FINANCES AND THE TARIFF TO BE FIXED FOR SALE OF WATER

The basis for the computations of the cost of water production and delivery to the consumer should be compared with the existing tariff and the quantity of water produced by the scheme which will not be constant throughout its life, but will initially be limited to that quantity needed to meet the supply deficit and then increase with demand growth to the full capacity of the scheme. Then the actual cost of the water delivered by the scheme will be significantly greater than estimated.

The simplest form of a water rate is a flat rate payable monthly or quarterly by the customer regardless of the quantity consumed, the services being metered. Many local bodies also adopt the system of a fixed tap rate charged per tap irrespective of the quantity used. However, the most equitable method will be based on metering of all the supplies.

The water rates are to the carefully fixed taking into account the following:

1 The rate should be high enough to fetch the necessary revenue and not excessive so as to discourage customers from making use of water.

2 The rate should be such as to make the amenity more or less self paying and worked as a "No profit-No loss basis".

It is desirable to review the tariff rates often. The revenue can be realised by proper billing and collections of the bill amount and also detection of unauthorised domestic as well as industrial connections and taking severe action on defaulters. Efficient and effective management in billing and collection and meter reading will realise full revenue which can be utilised for the proper maintenance of water supply system as well its future improvement.

The quantity consumed by a customer depends upon the type of supply such as intermittent supply or continuous supply. A continuous supply with normal pressure of water to the consumers not only avoids wastages but also makes the consumers fully satisfied and encourages him for prompt payment of tariff. In that event, a flat rate, services being metered payable monthly or quarterly will be the simplest form of water rate at yearly intervals.

Sample surveys in different places revealed that the consumption of water in a continuous supply system is almost equal to the intermittent system provided preventive measures are taken to prevent and arrest leakages and wastage by proper monitoring.

The Indian conditions need unmetered flat rate system per tap and its size. This prevents repairs of meters and its replacement frequently due to various reasons. The flat rate system can easily be fixed as the quantity can be arrived by discharge through a tap with a known pressure. This avoids mis-management of maintenance and billing of meters and this staff can be utilised for other purposes such as monitoring and leak detection and in R& D cells.

A more thorough evaluation of future water demands and more thorough evaluations of the utilisation of existing and nearby water resources including ground water, can significantly bring down the cost of production of water and its delivery. The revenue from the sale of water or water rates recoverable from the parties actually consuming the water such as for domestic purpose or for industrial purpose is generally utilised to meet the annual recurring cost of operation and maintenance and to provide for a reserve for meeting the capital expenses for future improvement and replacements of the system.

The planning and the number of decisions taken both at policy and technical levels, plays a very important role for estimating the cost of a particular water supply scheme. Number of alternatives also have to be taken into account in estimating approximate but fairly reliable cost of the full project. A critical analysis in financing capacities of the Bodies which undertake the project and the methods by which the project could be made financially self supporting also have to be made for arriving at the cost of the project. The other factors that also influence the estimated cost of the project are Source Selection, Quality of Water, Treatment Measure, Conveyance of Supply, Distribution System, Local Sources of Powers &Land Acquisition. By forecasting intelligently the above, the cost of the Scheme can be arrived at in the most economical way. However, in actual practice the estimated cost of the scheme and funding the scheme will depend upon the availability of the resources.

On the basis of less capital cost of estimate and its various components, the production cost of water can be worked out economically. Therefore, a reliastic estimate for each of all the alternatives must be made after duly obtaining necessary field data such as Survey, Soil and Subsoil investigations and carrying out detailed designs of treatment and selecting the best possible and other comprehensive feasibility study for drinking etc., and taking up project work for meeting the immediate needs of the area as well as expanded supply to meet the growing demands in the future.

CONCLUSION

By creation of Autonomous Water Boards, it is easier to raise the Finances from the Local Resources and the open market to supplement the provisions from State Governments.

These Boards can have very good control over all activities including production, conveyance and distribution of water within their statutory areas and also for the collection of Revenues. The Board can also manage the Systems more efficiently to the full satisfaction of all the community.

A water supply organisation should be treated as a Business enterprise involving management skills and Engineering knowledge to make the scheme successful and safe in practice and also in financial considerations.

For safe and proper quality of water supply, which should be the prime consideration of the organisation, it is desirable that the management be headed by a highly qualified Public Health Engineer. □

Financing and Management of Water Supply Schemes in Metropolitan, Municipal and Trans-Municipal Projects

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1. Introduction:- Water is an integral part of man's environment and the extent to which it is abundant or scarce, clean or polluted, beneficial or destructive, determines to a large degree, the quality of his life. The relentless increase in the demand of water for various purposes brought about by population growth and agricultural and economic development, rise in standard of living, combined with poor efficiency in water use and increasing pollution of water supplies have raised serious problems. Water is a limited and valuable resource - it can no longer be taken for granted free. Yet it is an integral and inseparable part of human life and hence available water must be developed optimally, economically and used most beneficially under appropriate priorities of use consistent with the requirements of the region. Terrestrial waters are subjected to various pollution now-a-days and if this continues unchecked it is feared even enough potable water for domestic consumption may not be available in future.

With the above in view the water supply schemes in the country should be planned, executed, run and maintained. And in each of these stages financing and management are very important which, if not taken proper care of, can emerge as serious impediments.

This paper limits it's discussion on financing and management of water supply scheme for metropolitan, municipal and trans-municipal projects in general with particular reference to Calcutta Metropolitan Area (CMA) and water supply schemes run by Calcutta Metropolitan Water and Sanitation Authority (C. M. W. S. A.), the body formed in 1966 and presently engaged in partial water supply of the Area (CMA). However, CMW & SA was recommended in Basic Development Plan of Calcutta as the Functional Agency solely responsible for water-supply schemes for the entire Calcutta Metropolitan Area.

CMA is the conurbation formed around the city of Calcutta covering approximately 450 sq. miles extending for a distance of about 50 miles along the Hooghly river (Ganga) to a depth of from 1 to 17 miles from the banks on either side (Fig-1). This vast area includes 2 Corporations, 33 municipalities and some 34 non-municipal urban towns. The present population stands at around 12.5 million. Though the projections made for the purpose of Master Plan of the city shows the population to be 14.8 million by 2001, it is likely to go much higher up due to heavy pressure of immigrants from neighbouring states and countries and also

due to rapid industrialisation and employment potential of the area.

2. Population forecasting and Water demand:- Management encompasses a series of activities of which the first and foremost would be planning upon which rest the others. Planning includes the basic guidelines which are to be followed in principle. It is the responsibility of the society to provide for safe, sufficient water for drinking and other uses of it's inhabitants. And the Planning Agency has also to standardise the average consumption per capita for which water supply schemes are to be designed. This should be in consistence with resources of the government and general economy of the people. As per norms adopted by Agencies responsible for water supply in CMA and as recommended in the Master Plan of Calcutta, theoretical rate of consumption of water till 2001 for the purpose of system design is as follows–though subsequently it seemed a bit optimistic to achieve.

i) @ 60 G.P.C.D. for densely populated area of Howrah & Calcutta.

ii) @ 50 G. P. C. D. for the rest of CMA.

— these take in account normal loss in pipelines. In addition to this there has been an estimated Industrial requirement of 427 M G D. Forecasting of population with various considerations viz. rate of mortality, fertility, migration etc. projects the figure of 14.8 million population by 2001. — which gives approximately 790 M G D of domestic water demand with the above stated standards. In addition to all these, another 10 M G D is estimated for fire-fighting, road-cleaning, sewer-maintenances etc. It is apparent from the above that ensuring such a huge quantity of daily supply calls for effective financing and proper management of the schemes.

With the total projected demand determined, next step is to find out the present existing capacity and their efficiency. This seems to be a bit difficult especially in the context of C M A as a number of Agencies namely C M W S A, Calcutta Municipal Corporations (C M C), Calcutta Metropolitan Development Authority (C M D A), individual municipalities etc. are engaged in water supply within the same area. Since there exists a lack of centralised Monitoring Authority, finding a total picture of the present day capacity and their prospects becomes difficult. Moreover, there remains a lot of industries, big hotels and private houses which have their own water supply systems which remain unaccounted for. Ascertaining the requirements precisely is very important so that the works are not designed oversized to such an extent that the capacity is only partly utilised for a long time inourring opportunity loss due to idling of capital resources. One more important point at this stage is determining the realistic duration (life expectancy) of various components of the project from economic considerations. This should be done by assuming effective rate of interest (cost of capital) and finding out the present worth of total investment throughout the useful life of that component.

Available statistics show the following existing provision for supply of water in four major cities of India.

Delhi	—	52 G P C D
Calcutta	—	47 G P C D
Bombay	—	28 G P C D
Madras	—	15 G P C D

In other municipalities of C M A there exists provision for 9 to 24 G P C D supply of water.

4. Financing and management:-

Cost of water supply schemes before investments are assumed to be self-liquidating as far as possible and proposed to be charged to beneficiaries. Also in general, better management and small Capital outlay are embarked upon.

Different stages of requirement of financing can be broadly classified as

i) Creation of Capital Assets inclusive of preoperative expenses.

ii) Operation and maintenance of the schemes.

4.1 Creation of Assets inclusive of preoperative expenses. Diff. cost Centres for this are-

i) Collection of Raw Water/Head Works

ii) Treatment units/Water works.

iii) Distribution Grid.

iv) Preoperative expenses.

Detalled project costings are to be prepared keeping provision for contingent expenses (nor–

mally @ 5%) and cost of work charged establishments.

If provision for consultancy, Supervision and project management is required to be made, a further margin of about 10-12% is to be included which may be eliminated if these could be performed departmentally.

The following data based on estimates made during 1975 & 1987 for two similar but different Calcutta-based plants of 60 M G D and 20 M G D capacity respectively, will give some idea about cost composition of different elements–

Estimate made in the year Capacity of Plant	1975 60 MGD (As% of total cost)	1987 20 MGD (As% of total cost)
i) Head works (intake Jetty, Raw Water Pump Station, Rising Main, electric etc.)	8.6%	10.34%
ii) Water works (Chemical House, Chlorinators, clarifiers, Filter beds, C.W. Storage, Filtered Water Pump stations, electricals etc.)	29.66%	28.32%
iii) Distribution Grids	55.82% (involves 45 KM Primary Grid and 435 KM Secondary Grid Cost ratio: 42% and 58%)	54.00% (Considering only 27 KM of Primary Grid)
iv) Pre operative Expenses (Land and Land development, Administrative office, staff quarters, Road/Drainage, landscaping, office furnitures, telephone, transport etc.,)	6%	7.34%
Average cost of Capital investment per 1 MGD supply (Approx)	35.66 Lakh	110 Lakh

The above compositions and costs are subject to vary depending on different types, designs and capacities.

4.1.1 Financing Pattern for creation of Assets.

The prevalent modes of financing which are in use are-

i) State Plan Allocation

ii) Bustee Improvement Grant from Central Govt. (B.I. Grant)

iii) Minimum Needs Programme of Central Government

iv) Market Borrowings

v) World Bank loan disbursed through Central and State Government.

Calcutta Metropolitan Development Authority (CMDA) though distinct from Calcutta Metropolitan Water and Sanitation Authority as functional organisations, these two have same Board of Management and CMDA virtually acts as Financing Authority of CMWSA as well. Prior to 1982 CMDA used to receive special Central Assistance in the form of loan for a handsome amount (about 10.5 Crores annually) from Central Government and an equal amount as Matching Grant from State Government. But after 1982, in view of the huge loan accumulation, this assistance was stopped and the loan accumulated till then was converted as "Grant". Instead the annual State Plan Allocation was substantially increased to match this. B. I. Grant from Central Government is received by CMDA in the order of 8.3 Crores annually.

Minimum Needs Programme of Central Govt. again provides for about 5 Crores annually as Grant against ensuring minimum civic needs especially for the economically weaker section of the population.

CMDA is empowered for Market Borrowings by floating 'Bond' etc. to the public, banks and financial institutions.

50% of the octroi charges paid by vehicles/commodities entering into CMA are provided to CMDA which covers the debt servicing and principal repayments of market borrowings.

Another very important source of Capital financing is World Bank loan which Government of India receives (in foreign exchange) as a % of (normally 70%) executed work costs on a very soft terms. This is further disbursed to functional agencies through State Government. CMWSA is now

executing one such World Bank-Financed water treatment project of Capacity of 20 MGD and which is proposed to serve 7 municipalities within CMA.

4.1.2 Management during Project Execution:- The aim is to complete the execution on schedule at a minimum cost. Water Supply Schemes, since encompass a larger area under jurisdiction of different Authorities and since it has to observe requirements of these different agencies - Project management becomes all the more important.

Some areas where the Project Management should thrust upon based on this Authority's (CMWSA) experience while constructing a trans-Municipal 20 MGD capacity water supply scheme intended to serve 7 municipalities, are enumerated below:-

4.1.2.1 Materials Management:- Timely procurement of key materials viz. Cement, Reinforcement Steel, Pipes, Pumps, Motors etc. should be ensured so that progress is not stalled at any stage of work for want of any material.

4.1.2.2 Project Monitoring:- Adoption of Network Analysis techniques (PERT/CPM) is essential for close monitoring of the schemes. Norms regarding evaluation of tenders, payment terms etc. should be standardised so as not to cause any unnecessary delay.

4.1.2.3 Large water supply schemes step into jurisdiction area of various other functional/utility agencies. Often it is required to obtain Consent/Approval/Sanction of these departments in various aspects which is normally a long time taking process and hence should be planned well in advance.

4.1.2.4 Appraisal:- All concerned departments, municipalities, local administrations, ultimate beneficiaries in relation to the project should be appraised about aims, limitations of the Project so as to obtain the maximum co-operation from them.

4.2 Operation and Maintenances (O&M)

4.2.1 Different elements of O & M costs are-

i) Salary + Wages

ii) Chemicals (Alum. + Chlorine) and consumables.

iii) F.O.L. including electricity charges

iv) Repair and Maintenances

v) Depreciation charges

vi) Loan Repayment.

A. Salary, Wages and administrative costs depend on manning pattern and efficiency of human resources engaged in the scheme. Hence it calls for an efficient management for cost reduction.

B. Chemicals, consumables, F. O. L., Electricity have stipulated consumption pattern and hence uniform costs. Bat wastage in each case is to be minimised and inventory holding to be optimised.

C. Repair and maintenances – should be provided as a % of plant capital cost. This % will be less during the initial period of the project life cycle and increases with ageing. Not all the sum would necessarily be expended every year and the balance would accumulate to provide funds for major repairs

D. Depreciation charges:- It is provided for the plant replacement funds - On equal annual instalments so that these when compounded, aggregates to the initial cost of equipment or structure at the end of their useful life. For charging depreciation, the life span of mechanical equipments are generally assumed as 20 years and that of Civil Engineering structures as 50 years. If P be the investment for the component having expected life span of 'n' years and assumed rate of interest for charging depreciation be 'r', the annual charge of depreciation Q is given by

$$Q = P \times \frac{r}{(1+r)^n - 1}$$

E. Loan repayment:- Ammortisation of loan is made on an equal annuity basis based on prevailing rate of interest.

If p = Initial Loan, i = Rate of interest

n = No of instalments

$$\therefore \text{Annuity } A = P \times \frac{i(1+i)^n}{(1+i)^n - 1}$$

Repayment of loan expended in any particular component can also be made over the period of their life span on equal annual instalment basis

Subheads A+B+C+D+E give the annual O&M Costs.

4.2.2. Making an allowance of 25% to cover for 15% line loss, 5% free supply and 5% bad debt, the unit cost of production is theoretically determined for 75% efficiency of designed capacity based on O&M cost determined above.

The following figures give the actual O&M costs in different years incurred in Garden Reach Water Works - a 60 MGD plant run and maintained by C. M. W. & S. A. and collection (anticipated) of water bills against them-

		Year 1987-88	Year 1988-89
1	Total Water Distributed (in million Gallon)	9533	8688
	Break up a) Industrial	30	28
	b) Institutional	332	271
	c) Bulk Supply to Corporation	8802	7959
	d) Bulk Supply to Municipality	369	430
2	Annual O & M Cost (Rs. lakh)	403.37	522.78
3	Average Cost of production for 1000 Litre	0.932	1.325
4	Anticipated revenue as per billing based on existing tariff (Rs. Lakh)	194.65	186.10
	Break up a) Industrial @ Rs. 2.50/KL	3.67	3.47
	b) Institutional @ Rs. 1.50/KL	22.95	18.77
	c) Bulk Supply to Corporation @ Rs. 0.70/KL	163.00	158.00
	d) Bulk Supply to Municipality @ Rs. 0.30/KL	5.03	5.86

Consumers are categorised in different groups and cost of water is charged from them at different rates. The following subheads 'A' and 'B' give the consumer categories and rate tariff that exists at present and that has been proposed to be made effective from 1st April 1990 in CMW & SA.

		Category	Rate per 1000 Litres of Water (Rs.)
A.	i)	Industrial	2.50
	ii)	Institutional & Commercial houses	1.50
	iii)	Municipal Corporation (domestic)	0.70
	iv)	Municipalities	0.30
B.	i)	Industrial (Profit earning)	3.50
	ii)	Institutional (Non Profiting)	2.25
	iii)	Municipal Corporation (domestic)	1.05
	iv)	Municipality and Panchayats (domestic)	0.45

4.2.3 Metering, billing and collection:- Since no individual meters is set up in all connections, billing is made on different basis viz. a) Flat rate charged monthly for every connection(adopted in CMW&SA) ii) Taxes on valuation of properties iii) Taxes based on no. of taps. iv)On the basis of actual consumption metered(as is adopted in CMW&SA in case of industrial, Institutional and Bulk supply to municipalities). Billing in CMW&SA is done quarterly @ Rs.10/- per month(propose to be Rs. 15/- per month from 01.04.90)

4.2.4 A Comprehensive O & M programme (if possible with computer orientation supported by an automatic or semi-automatic monitoring system) is a must for smooth functioning of any treatment plant.

O&M Management consists of two parts.

A) Production Management.

B) Maintenance Management.

4.2.4.1 Constraints in O&M.

i) Non availability of funds for O & M in time.

ii) Non–realisation of water bills from consumers.

iii) Factors that stand as impediments towards self viability viz. Non-structured peoples participation, interference of influential groups/ political parties, non–realisation of sale proceeds, wastage, pilferage of water, lack of significant preventive maintenances, conceptual impoverishness of people in taking water as a saleable commodity, bureaucracy in administration.

iv) Deficient skilled and trained personnel.

v) Lack of proper routine maintenance programme that in turn necessitates increased breakdown/curative maintenances.

vi) Non-adoption of scientific management techniques in O&M, in procurement of chemicals, consumables, spares etc. Considering their essentiality, price and lead time for procurement.

vii) Non-attendance to public complaints that grows public grievances and leads to dispute.

viii) Human factors-lack of dedication/ motivation, negligence (accountability being very low in Govt. / Semi-Govt. Sector), patronage by political parties/ influential groups to move in a self–willed manner.

ix) Deficient safety programmes.

x) Non-structured interactions with local administration and other government utility departments.

4.2.5. Recommendations.

i) Allocation of funds for O & M need be ensured in time. A seperate reserve fund either meant for this purpose or some other purposes may be used for crisis management in case of non-availability of allocated fund and be readjusted as soon as this arrives.

ii) Systems to be adopted for regular and timely collection of water bills. Rebate/Penalty may be introduced for timely or delayed payments respectively. Stringent norms may be developed and enforced in case of nonpayment. Infrastructure has to be developed for continuously assessing the collection proceeds and to decide on the necessary measures.

iii) A few vigilance groups may be formed to keep a check on pilferage and wastage.

iv) Routine maintenances should be regarded as a direct measure to minimisation of break downs and harmful depreciation of plants and equipments. Hence, periodical inspections is a must for the purpose of routine maintenance. Hence it is theoretically possible to establish a schedule of inspections and shut-down to minimise frequency of breakdowns. But infrastructural inadequacy and high cost of such inspection programme may render them unoperative and outweighs the cost of break-down, repair and replacements. Hence, a balancing point should be found out between routine maintenance cost and repair–replacement costs so that total maintenance cost would be minimum– and in consistence with the infrastructure available. Preventive maintenance works should be timed in such a manner that it is evenly distributed throughout the year thereby eliminating excessively busy weeks for maintenance crew with accompanying haphazard inspection.

v) Training programmes for different levels of personnel (Operator, Supervisors, Engineers, Executives) should be organised either inside their water works or outside or in some other similar water-works which not only develop their skill and update their knowledge but also result in higher motivation and morale of the people.

vi) Net work Analysis and other management techniques should be adopted to monitor the coordinated activities and evaluate the ultimate performance.

Procurement of essential chemicals (viz.Chlorine, Alum) etc. should be planned well in advance and economic order quantity fixed so that optimum expenditure is incurred with no fear for shortage or surplus of material.

Inventory of spares and their management is very important. For the classification of spares V.E.D (Vital, Essential, Desirable) system of classification may be adopted and items stressed upon accordingly.

vii) Formation of a Public/Consumer grievance Cell is felt necessary for expeditiously attending the public complaints so that they can be sorted out early and undesirable consequences avoided.

viii) Active promulgation and enforcement of different safety programmes for protection of personnel and property is very important. Each and every personnel should be trained for safe handling of equipments and knowledge for fighting hazards in case of an accident. □

Preventive Maintenance of Water Treatment Plant

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(A) INTRODUCTION

The term 'Maintenance' in an engineering sense may be defined as the art of keeping plant equipments, structures and other related facilities in optimum working order.

The person in-charge of the maintenance and operation should have a thorough knowledge of the functions of the several units under his control. The problems that may be posed before him may relate to those arising from (a) poor design, (b) faulty execution, or (c) special situation during operation.

A resourceful operator should be in a position to bring to the notice of the concerned person, any faults in design and execution giving rise to problems during the course of operation and rectify them immediately. The other problems which are to be tackled at the operational stage are mainly those which arise out of:

a) fluctuations in the quality of the water;

b) fluctuations in the quantity and changes in the flow pattern because of season change or similar reason;

c) malfunctioning of the several units; and

d) mechanical and electrical equipment

Maintenance should be carried out in a manner which prevents emergencies and unscheduled shutdowns. An efficient maintenance requires considerable skill which can only be acquired by experience, study and practice. Basically any maintenance programme should observe the following general rules:

a) Keep a set of plans giving details of the several units and indicating the layout and position of all pipelines and appurtenances;

b) Prepare a systematic plan of daily operations

c) Prepare a routine schedule for inspection of machinery and lubrication and maintain records thereof. Instructions for lubrication, the type of lubricant suggested and the frequency of lubrication should be drawn out;

d) Maintain data and record of each piece of equipment giving details of cleaning and replacement of worn parts & other data of importance such as unusual incidents and faulty operating conditions. Details for any special equipment should be obtained from the manufacturers;

e) Keep a record of analysis of water collected at various points from the source to the distribution system and observation on the effect of such quality on the several units of operation and

f) List out safety measures including good house keeping.

(B) RAW WATER

The problem will mainly relate to the change in the quality of the raw water due to natural causes and by inadvertent pollution of the source.

(C) AERATOR

i) Gravity type aerator
Normally cascade type aerator consisting of a flight of steps and collecting channel is in use. Slime and algal growth is one of the most

common problem with such type of aerator. The problem is minimised if the rise and trade of such an aerator is surfaced with glazed tiles. Periodical maintenance is done by passing the aerator and applying concentrated solution of chlorine to the slime and algal growth and after minimum 12 hours contact lime brushing with hard wire brush. In very rare case $CUSO_4$ solution may be used in place of chlorine solution but then aerator surface has to be thoroughly cleaned after 24 hour contact period before the aerator is put in operation.

ii) DIFFUSED AIR TYPE AERATOR

When diffuser's plates get clogged because of algal growth, the diffuser plates require periodic treatment with copper sulphate and lime. A Solution of 10 gms of copper sulphate and 10 gms of hydrated lime per litre of water is prepared.

The aerator is first bypassed and then the solution is applied with a large brush, the contact time provided is 24 hours after which the surface of the aerator is thoroughly washed and then the aerator is put back in use.

Diffuser plates may get partially clogged either from dust in the compressed air or from the collection of sediment on the outside surfaces when aerator is shut down. If air pressure on the diffusers are maintained when compressors are shut down by closing the valve on the compressed air piping then clogging due to collection of sediment on the outside surface is minimised. Clogging of diffuser plates from inside is normally because of dust particulate matter from air and oil traces from compressor. Dust clogging could be minimised by maintaining air filters in effective operation while oil clogging could be minimised by avoiding over-lubricating air compressors or blowers and providing oil trap between compressor and diffuser plate.

If clogging is due to rust from an air pipe, acid treatment is needed. Removable diffusers may be placed in 50% nitric acid prepared by adding concentrated acid to the same volume of water. If however, the diffusers are grouted in place by cement mortar, an 'inhibited acid' must be used. This is prepared by adding I am of sodium dicromate to each of 50 ml concentrated sulphuric acid.

iii) SPRAY AERATOR

Spray nozzles are normally clogged which are treated more or less the same way as diffuser plates. Nozzles could be cleaned even by introducing the hard wire through it.

(D) FLOW MEASUREMENT

Float sump should be periodically cleaned to see that silt and clay does not accumulate which may effect the proper functioning of the float. Charts and pen recorders should be stocked adequately. Annual or more frequent calibration of these devices is necessary. Annual servicing and checking of the instruments is imperative.

(E) CHEMICAL FEEDING

Alum preparation tank is to be painted annually by anticorrosive paint. V-notch weirs and floats and floating arrangements should be cleaned daily. Enough spares for the mixing device in the chemical preparation should be stocked. Setting of the V-notch should be checked periodically.

Sometimes, if the alum dosing equipment is not in order, alum slabs are just dumped in the raw water channel. This is a bad practice and should not be adopted as it will mean wastage of alum and improper dosing of alum. Alum should be made into a solution and dispensed until the dosing equipment is rectified. The optimum dosing of alum and coagulant aids should be based on a proper and detailed laboratory study including Jar Test. The chemical feeding rate should be controlled, depending upon the needs from time to time.

(F) FLASH MIXING

Adequate spare should be kept in stock for timely replacement when necessary. Life of the equipment could be prolonged by periodical painting with anti-corrosive paints.

(G) FLOCCULATION

Flocculation should be operated continuously for avoiding sludge buildup. Moving parts should be painted with anticorrosive paints every year. Electric devices should be properly lubricated and worn parts replaced. In nonmechanical type of flocculators like baffle and tangential flow tanks, desludging at least once in six months is necessary.

(H) SEDIMENTATION

Annual overhauling and repainting of the unit should be done a month or two prior to monsoon.

Sludge lines should be kept free of chokages. The lines should be flushed with high pressure water if chokages are noticed. The telescopic sludge discharge device, when provided, should be checked for free vertical travel movement and O-rings replaced when leaky. The traction wheels should be checked for alignment, and rubber wheels replaced if required.

The unit should be worked continuously to protect the mechanical parts from ill-effects of corrosion, malfunctioning, etc. as well as problems from sludge build-up. Outlet weirs should be kept cleaned at all times. Bleaching powder may be used for controlling biological growths on weirs.

The important features in the operation of a clarifier are:

a) the introduction of water into the tank with a minimum turbulence;

b) the prevention of short-circuiting between inlet and

c) the removal of the effluent with the minimum of disturbance to avoid settled material being carried out of the tank.

Very often, a basin which is not functioning properly can be modified by making changes to the inlet and outlet devices of it by installing stilling baffles so as to improve any or all of the important features mentioned above. Algal growths, if any, should be controlled by pre-chlorination.

(I) FILTRATION

Rapid Gravity Filters

The common problems encountered with rapid gravity filters are:

a) Defective gauges

Rate of flow gauges and loss of head gauges frequently get out of order. The operator should be conversant with the working of order and should be able to handle minor repairs. Necessary spares should be stocked.

However, even if the rate of filtration gauge is under repair, the filtration rate can be checked whenever desired by closing the inlet valve and observing the time during which the level of water in the filter falls by a measured distance.

For knowing the loss of head when the gauges are out of operation, a stop gap arrangement consisting of two glass tubes on each side of a calibrated scale could be provided. One tube is to be connected to the effluent pipe between filter and rate controller and the other tube to the filter structure above the sand. The relative elevation of the water surfaces in these tubes indicates the prevailing hydraulic gradient or loss of head through the filter.

b) Inadequate Media on the Filter Bed

Expansion of sand bed during backwashing should be kept within the limits to avoid carry over of sand to wash water through which would lead to appreciable depletion of sand depth over a period of time. Sand depth should never be depleted by more than 10 cm after which the media has to be replenished. The entire bed should be taken out and additional sand mixed to give the required effective size and uniformity coefficient. Before starting the filter, the sand has to be backwashed to stratify the bed.

(c) Air Binding

This is caused due to the development of negative head and formation of air bubbles in the filter sand. This could be overcome by more frequent back-washing during these periods. Provision should also be made for increasing the depth of water over the bed by about 15 to 30 cm. There are chances of air being released by back-wash if carried out by pumping. Air release valves should be provided on the pumping mains in such cases.

The solution lies in providing adequate depth of water atleast 1.5 metres., over sand. If airbinding persists, loss of heads may be limited to 1.5 metres instead of normal 2 metres. This will discourage air binding and will ensure reasonable length of filter runs.

(d) Incrustation of Media

This problem may arise as in the case of water softening with lime soda when sand gets coated with material that is difficult to remove

by normal back-wash. The remedy lies in washing the filter occasionally with sodium hydroxide (10 Kg/sq.m. area of bed) or bleaching powder (20 Kg/sq.m area of bed).

(e) Cracking of Sand Beds

This occurs mostly when the water is lowered below the surface of the sand. Cracks in a sand bed under water, may also arise due to the cementing of the grains by some materials in the applied water. The vulnerable portion is near the filter walls, since the sand is drawn away from the walls. The rate of flow increase through such cracks allowing a heavier deposit of solids at these points, which in turn, intensifies the force compacting the sand until a dense mass is formed. The degree of agitation of this mass may be limited, creating a dead area, resulting in an equa. unequal distribution of the wash water. This can be overcome by the use of hand rake or by draining the bed and removing the clogged sand.

(f) Bumping of Filter Beds

Sometimes careless and indifferent operation may lead to 'bumping' or lifting of the filter beds when switching on the back-wash for a minute to dislodge the sand bed and restarting filtration without going through the full back-wash cycle is adopted. This practice should be discouraged as the filtrate quality deteriorates considerably.

(g) Mud Balls

These are caused by the general build-up of materials not removed in back-wash. Mud balls accumulate at or near surface and in course of time clog the entire media.

By proper coagulation and setting of applied water, mud-ball formation could be considerably reduced. Surface wash, or surface racking, or shovelling at intervals helps reduce mud ball formation. Also compresses air scouring during backwash for periods of three minutes, instead of 1 to 2 minutes, effectively decreases mud ball concentration.

A test is carried out to know the ratio of volume of mud ball larger than 2 mm size to the volume of filter media in the upper 15 cm layer, since during the early stage of filter deterioration, mud ball concentration is highest in the top 15 cm layer. The condition of fhe filter is related to the percentage of mud balls as follows:

Per cent volume of mud balls	Condition of filter
0.0-0.1	Excellent
0.1-0.2	Very good
0 2-0.5	Good
0.5-1.0	Fair
1.0-2.5	Fairly bad
2.5-5.0	Bad
Over 5	Very bad

h) Sand Boils

These are caused when disproportionately large discharge of wash-water rush upwards expanding the sand displacing the gravel. The situation is encountered mostly due to the poor distribution of wash-water from the underdrain.

i) Slime Growths

When slime growths are noticed on filters, the bed is cleaned in the normal way and the water is lowered to the level of the sand bed. Then common salt is distributed evenly over the surface of the sand, using 7 Kg/sq. m. of filter area, after which the washwater valve is opened until water rises about 15 cm. above the sand level. The water is allowed to remain for 2 hours to dissolve the salt and then lowered to the bed level to be retained for 24 hours after which it is thoroughly backwashed before placing into service. If this procedure does not produce effective results, it may be necessary to replace the media.

j) Backwash Requirements

The waste water drains carrying filter backwash, should be kept free of clogging or sediment. If the backwash is led away quickly there will be no backing up in water channels, or in to the filter bed. Incidentally, it may be worthwhile to consider setting up a plain sedimentation tank to recover the supernatant from the backwash. For the small investment, water recovery could be appreciable.

The requisite upflow velocity of backwash water should be maintained at the designed rate for proper cleaning of the sand. The practice of backwash at reduced rate for longer periods should be avoided as it leads to wastage of water and washing becoming ineffective.

Backwashing of filters should not be on arbitrarily fixed time schedules but the frequency should be in accordance with filter quality and head loss measurement. Duration should be dependent upon the turbidity of the wasted water.

k) Cleaning Rapid Sand Filters

It may be necessary at times to clean the filter sand or the gravel to overcome difficulties from mud balls, cracking and other causes. Usually cleaning serves only as a temporary expedient. The cause of clogging should be corrected. Chemicals such as caustic soda, sulphuric acid, hydrochloric acid, soda ash, sulphur dioxide and chlorine could be used for the purpose. Chlorine may be used where the material to be removed is of biological origin, copper sulphate may be effective against algae, caustic soda for alum deposits and organic material, hydrochloric acid or carbonic acid against calcium carbonate; and sulphur dioxide for dissolving iron, manganese or alum H.T.P., perchloron or clorox may be used in small filters. Liquid chlorine is more economical on large filters. Chlorine may be applied as a solution at a concentration of about 50 ppm of available chlorine. The solution should stand in contact with sand for 24 hours or longer. Caustic soda can be applied as a solution or, perferably, by spreading 5 to 15 kg. of the flaked material per sq. m. of the filter surface. The soda is dissolved by water allowing the wash water to rise 10 to 15 cms above the sand. Sulphur dioxide has been used as a patented process, to clean filter sand coated with iron or manganese. A 1 to 2 % aqueous solution of sulphur dioxide is pumped into the filter and circulated through the under drains and the filter for a period of 24 hours. The method is not recommended where the sand grains are coated with calcium carbonate because of the possibility of cementing the grains together with calcium sulphate or sulphite.

Before acids or other chemicals are applied to a filter, samples of the sand to be cleaned should be tested in the laboratory with the chemical to be used. Some concentrations and periods of application of chemicals that have been used with varying degrees of success are indicated in Table No. 1.

TABLE 1

CHEMICALS USED FOR CLEANING FILTERS

Chemical	Amount of chemical or strength of solution used		Period of contract
1. Caustic Soda & Soda Ash	NaOH Na2Co3	9 kg/Sq.m. 26 kg/Sq.m.	48 hours
2. Caustic Soda	4 to 6 kg/sq.m.		24 to 72
3. Soda ash	0.024 kg/L		24 to 36
4. Sulphuric acid	0.5 kg/sq.m.		4
5. Chlorine	50 ppm		48
6. Sulphur dioxide	2%		16

The filter must be thoroughly washed to remove the loosened substances and to remove the chemicals. The handling of chemicals used in the cleaning of rapid sand filters is hazardous hence adequate care is required.

(I) FILTER GRAVEL

Displacement of the gravel in a filter may result from a break in the under-drainage system, from uneven distribution of the wash water or from the use of too high a rate of wash. The condition aggravates the unevenness of the wash-water distribution, mixes the gravel with the sand and may permit the escape of sand into the underdrains.

The condition may be remedied by diminishing the rate of filtration or by repairing or renovating the under-drainage system. Gravel that has become misplaced in a filter may sometimes be replaced without shutting down the filter by drawing a straight edge across the surface of the gravel while back washing the filter. The fine gravel, which is almost suspended in the rising wash water, is easily shifted about in this manner.

(J) CHLORINATION

a) Only trained personnel should be permitted to handle chlorine cylinders and chlorinating equipment. They should be made aware of the hazards involved, the precautions to be observed and first aid to be rendered in emergencies. Rubber gloves, aprons and suitable gas masks should be provided. These should be housed in an easily accessible (unlocked) cupboard placed outside the chlorinator room. It is very important that the operating personnel are trained in the proper use of gas masks. A faulty gas mask is worse than none at all. Hence it is very important that these are tested frequently and the containers are changed at proper intervals.

b) When a chlorine leak occurs, the mechanical ventilation system should be opened immediately before any person enters the chlorine room. It must be made a point that chlorine container valves are closed first before any investigation is started.

c) Cylinders containing chlorine should be handled gently. They should not be bumped, dropped or rolled on the ground and no object should be allowed to strike them with force. The protective hoods over the valve should always be kept in place except when the cylinders are in use. Flames should never be applied to chlorine cylinders or their valves.

d) Cylinders should not be stored in the open or in damp places. Empty cylinders should be stored away from full cylinders so that they do not get mixed up. It would be desirable to tag the empties as an additional precaution. Incidentally, this will ensure prompt return of used cylinders.

e) In case the valve is found to be stuck, the cylinder should be immediately returned to the supplier. No attempt should be made to lease a stuck valve by hammer as this is very dangerous.

f) Only the spanners prescribed for use should be used as it is important not to put too much average on the valves.

g) Cylinders as well as the chlorinators must be tested at the start and end of every shift period, for leaks, first by trying to detect the sharp irritating smell of chlorine, then by passing over each cylinder and round each valve and pipe connections a rod, with a small cotton-wool swab tied on the end, dipped in an aqueous solution of ammonia. Any leakage noticed anywhere must be attended immediately otherwise same is going to lead major trouble in the plant. If chlorine is present in the air, the swab will appear to 'smoke' due to the formation of white clouds of ammonium chloride. If the leak appears to be heavy, all persons not directly concerned should leave the area and the operator should put on his mask and make a thorough search for the leak. In tracting a leak, always work 'down stream' i. e. start at the cylinder and work down along the line of flow until the leak is found. It will save many valuable minutes over the practice of starting in the middle of the chlorinator and searching vaguely back and forth over the whole equipment.

h) Water should never be applied to a chlorine leak to stop it as it will only make it worse. If the leak is in the chlorinator, the cylinder should be immediately shut off until the pressure has reduced. The joint or gasket should be repaired replacing with new packing, if necessary.

i). Solvents such as petroleum, hydrocarbons or alcohols should not be used for cleaning parts which come in contact with chlorine. The safe solvents are chloroform and carbon tetrachloride. Grease should never be used where it can come in contact with chlorine as it forms a voluminous frothy substance on reaction with chlorine. Only special comments recommended by manufacturers should be used.

j) No direct flame should be applied to a chlorine cylinder, when heating becomes necessary, as this is hazardous. A water bath controlled not to exceed 27 degree celsius should be used.

k) Before disconnecting the flexible lids from containers to gas headers, the cylinder valves should be first and then the gas under pressure should be drawn from the header and flexible lids before the header valve is closed. The exhaust system should be turned on and operated while the cylinders are being disconnected or repairs being made.

Handling Emergencies

As soon as there is indication of chlorine leak or other abnormal condition, corrective steps should be taken. Leaks never get better by themselves, they always get worse if not promptly and suitably repaired. Authorised trained personnel with suitable gas masks should investigate and all other persons should be kept away from the affected area. The ventilation system should be placed in operation immediately. Unconfined chlorine, being heavier than air, tends to lie close to ground levels. (The characteristic must be kept in mind in designing chemical storage and use areas and appropriate neutral or mechanical ventilation system.) If leaks cannot be handled promptly, the chemical supplier or nearest office or plant of the producer should be called immediately for emergency assistance.

In case of fire, containers should be removed from the fire zone immediately. Portable tanks, tank cars, trucks and barges should be disconnected and if possible, should be removed from the fire zone. If there are no leaks, water should be applied to cool the container. Water must never be applied to leaking chlorine container. Chlorine is only slightly soluble in water and the corrosive character of its reaction with water always will intensify the leak. In addition, the heat supplied by even cold water will increase the vaporization rate. Leaking chlorine containers similarly should not be thrown into a body of water because the leak will be aggravated and the container might float when still partially full, allowing uncontrolled gas evolution at the surface.

If a leak occurs in equipment or piping, the supply should be discontinued and the material under pressure at the leak should be disposed off. Leaks around container valve stems usually can be stopped by tightening the pack out or gland. If this action does not stop the leak, the container valve should be closed and material under pressure in the outlet piping should be disposed off. If the valve does not shut off tight, the outlet plug or cap should be applied. In case of a leaking valve of a top container, the container should be positioned so that the valves are in a vertical plane with leaky valve on the top.

(K) MAINTENANCE OF PUMPS

Periodic inspection and test

The maintenance schedule should enlist items to be attended to at different periods, such as daily, semi-annually annually, etc.

Daily observation should include:-

a) Leakage through packings,

b) bearing temperature,

c) whether any undue noise or vibration,

d) pressure, voltage and current readings,

Semi-annual

a) free movement of the gland of the stuffing box,

b) cleaning and oiling of the gland-bolts,

c) inspection of packing and repacking, if necessary

d) alignment of the pump and the drive.

Cleaning of oil-lubricated bearings and replenishing fresh oil. If bearing are grease-lubricated, the condition of the grease should be checked and replaced to correct quantity, if necessary.

An anti-friction bearing should have its housing so packed grease, that the void spaces in the bearings and the housing be 1/3 to 1/2 filled with grease. A fully packed housing will cause the bearing to overheat and will result in reduced life of the bearing.

Annual inspection

a) cleaning and examination of all bearings for flaws developed, if any.
b) examination of shaft-sleeves for wear or scour.
c) checking clearances:-

Clearances at the wearing rings should be within the limits recommended by the manufacturer.

Excessive clearances mean a drop in the efficiency of the pump. If the wear is on only one side, it means mis-alignment. Not only that the misalignment should be set right, but also the causes for the disturbances of the alignment should be investigated. When the clearances have to be redeemed to the values recommended by the manufacturers some general guidelines are detailed in Table-2

TABLE—2
RECOMMENDED CLEARANCES AT THE WEARING RINGS

Inside Diameter wearing of ring	Diametral Clearance, mm	Tolerance in machining, mm
Upto 100	0.3	0.04
100—150	0.35	0.04
150—200	0.4	0.06
200—300	0.45	0.06
300—500	0.55	0.06
500—750	0.58	0.06
750—1200	0.69	0.08
1200—2000	0.79	0.10

The basic sizes of the o.d. of the impeller or the p. d. of the neck ring should be tolerated +0.000. Similarly, the basic size of the i.d. of the wearing ring should be tolerated -0.000.

If the clearance on wear is seen to be 0.2 or 0.35 mm more than the original clearance, the wearing ring should be renewed or replaced to get original clearance.

Impeller-hubs and vane-tips should be examined for any pitting or erosion.

End-play of the bearings should be checked.

All instruments and flow-meters should be re-calibrated. Pump should be tested to determine, whether proper performance is being obtained.

In the case of vertical turbine pumps, the inspection can be bi-annual. Annual inspection is not advisable, because it involves disturbing the alignment and clearances.

Facilities for maintenance and repairs

Consumables and lubricants:

Adequate stock of such items as gland-packings, belts, lubricating oils, greases should be maintained.

Replacement Spares :

To avoid downtime, stock of fast-moving spares should be maintained.

A set of recommended spares, for 2 years of trouble-free operation should be ordered along with the pump.

Repair Workshop:

The repair workshop should be equipped with

a) tools such as bearing-pullers, clamps, pipe-wrenches, etc.
b) general-purpose machinery such as welding set, grinder, blower, drilling machine, etc.

REFERENCES

1 'Manual on Water Supply and Treatment' published by CPHEEO, Ministry of Works and Housing (1984)
2 J. R. Baylis, O. Gullans and H. Hudson, 'Filtration' Water Quality and Treatment, AWWA (1971), pp. 243-279.
3 J. L. Cleasby, E. W. Stangl and G. A. Rice, 'Developments in Backwashing of Granular Filters', Journal of the Environmental Engineering Division, ASCE, Vol. 101, No. EE 5, October, 1975, pp. 713-727.
4 C. R. Cox, 'Operation and Control of Water Treatment Processes' WHO Monograph No. 49 (1979)

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Financing & Management Of Water Supply and Sanitation Projects

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I INTRODUCTION

In the context of the rapidly growing population and rising aspirations of people, the main item of essential infrastructure, the provision of water and arrangements for proper sanitation, has become an urgent and pressing need of the hour in countries like India. Metropolitan regions, big cities and city agglomerations, Towns and villages of various sizes present different problems in respect of arrangements for water supply and sanitation.

It has been the experience of completed water supply projects that, those have improved the health situation by helping to check the spread of epidemics and waterborne diseases. This has obviously increased the demand for more such schemes, from everywhere. The augmentation of water supply has also created a pressing need for proper sewerage and sanitation.

The policy documents and the water supply and sanitation decade and the special attention by World Bank, HUDCO etc. to the infrastructure projects have prompted no. of agencies. Several projects have been and are being taken up. The formulation, appraisal, implementation, monitoring and operation and maintenance of water supply and sanitation schemes in various states in India, have brought out a no. of issues concerning the financing and management of such projects. The state Boards for Water Supply and Sewerage or the state Depts. or major municipal bodies which have been planning and executing such projects have faced a no. of problems and gained considerable experience and have generated thinking about the way the projects need to be planned and implemented.

Considering both Financing and Management of Water Supply Projects together, is very important and relevant in today's situation because these two are very much linked together. Financing or good ways of funding and recovering the costs, is an activity which is very much influenced by Management of the Water Supply Projects and vice versa. Several possibilities of saving resources have got to be taken into account in the phases of Planning, Designing, and Implementation of Projects as also in the operation of the systems so developed for which again adequate attention has got to be paid in the three phases mentioned earlier and the related activities.

It is proposed to discuss some important issues influencing the costs and management of Water Supply and sanitation projects. This discussion is based on the experience of examination of several projects and discussions with number of agencies at various stages of such projects as also regular operation of the systems. The main idea is that authorities concerned need to take a critical look at the whole gamut of this field and learning from the experience, should introduce urgently needed reforms in the whole framework, as soon as possible.

II THE STAGES IN WHICH BOTH FINANCING AND PROJECT MANAGEMENT NEED TO BE PAID SUFFICIENT ATTENTION

The important stages of such projects at which various aspects need to be cosidered are:-

1 Preliminary Investigations and Feasibility Studies;

2 Planning, Designing and broad Estimates;

3 Total Costs, Financial Viability and Analysis of sources of Funds;

4 General Scrutiny and Clearances, as also Administrative and Technical approvals;

5 Prior Preparations;

6 Implementation Process;

7 Monitoring for financial and physical performance and criteria for efficiency and deficiency analysis;

8 Other related matters.

These are taken up for discussion, in the paragraphs that follow.

III PRELIMINARY INVESTIGATIONS AND FEASIBILITY STUDIES

The general observation is that the time taken for this activity is too long. Besides investigations the state government and sometimes the central government are required to be consulted and decision–making at various phases is slow and time-consuming. Some other more specific observations are:-

(i) In some cases the investigations are not sufficiently deep enough causing considerable problems later, in the implementation phase requiring design changes and affecting the whole costs and therefore financial problems. Projects sometimes remain half completed for longer periods wasting the investments already made. It has also been the general complaint that concerned local governments are not consulted.

It is absolutely essential that the investigations have to be very much dependable and deep enough and the clearances are faster and the local governments are consulted from the beginning. It is also necessary that the overall Master Plans for state as a whole for 30 years or so, provide for certain resources to be exploited for 'Drinking Water purposes only or mainly' especially such of the sources nearby the growing urban agglomerations which will need large quantities of water in a foreseeable future. In all other sources depending upon the command areas and capacity of the source, the possibility of a reservation for drinking purposes say at least 15% be made by a government order itself. The relative merits using water economically and efficiently from alternative sources for particular towns or cities or developing areas must also be taken into account at such a stage or even later, if new projects are coming up after a reservation is made in the projects completed earlier and not utilised till then. The funding for the portion so reserved for urban or industrial or other bulk usage will obviously have to come from the respective departments/authorities at the initial or later stage.

In the source allocation or reservation, the possibilities of diverting some natural streams into the main source upstream of the dam or pumping from downstream into the main dam in periods after october also need to be taken into account (concept of pumped storages). It is also possible to reduce pipe cost by river regulation though there could be some losses in such a system by small weir downstream of the dam and supply by gravity through pipes directly from dam can help saving pumping costs and losses in river regulations in any case offers considerable savings. All such alternatives have got to be evaluated at the feasibility stage.

(ii) In many projects it is observed that the population estimates are not realistic. In some Projects those were too much on the high side requiring larger funds and therefore beyond the available means or sources of water. In some, the population estimates are gross under-estimates at times due to lack of appropriate forecasting of rapid growth or sometimes for the simple reason of getting the proposal through or sometimes restricting the scope to a smaller area though surrounding areas or areas en route are bound to ask for water which get added later. In some cases the investigations at a later stage when it is found that expansion is faster than the original forecasts, the investigations delay the implementation going on, depriving the people of their water needs and also added costs due to non-utilisation of investments made and also due to subsequent changes being made in the Project Design and Funding Pattern requiring fresh approvals and new sources of funds for the increased costs.

Persuading Irrigation Authorities to take into account the sewage water as source for the farming areas on the downstream is also important in the overall investigation and reservation stage.

Normally more realistic and sufficiently longer term projections and also realistic assumption would solve the problem. Perhaps the prescribed standard of 180 liters per capita may be too much as nobody uses so much water or should not be allowed to use so much water, it being such a precious commodity also needing complex arrangements to harness and supply. Sometimes such an over-provision of course has been found to come to the rescue in providing rapidly growing demand not envisaged earlier.

IV PLANNING, DESIGNING AND BROAD ESTIMATES

If the overall planning is not there and if the earlier phase gets extended into the period of subsequent phases as mentioned earlier, the complications pose insurmountable problems which has happened in many projects. Un-com pleted Projects are bound to suffer in such situations. It is therefore essential that in the Planning and Designing stage, all care is taken and realistic targets are fixed and realistic assumptions about sources of funds and realistic phasing is adopted.

All future requirements and operational requirements have not at times been taken into account. In some cases Overhead Reservoirs have been provided but have not been used for years together because of operational difficulties which could have been envisaged earlier. This situation gives more water to some areas and very less to others and complaints are galore.

It is necessary that pumps for raw water pumping are designed for normal water level variation and not for extreme cases, to reduce costs on constant high head pumping for higher depths. Special arrangements can be made for emergency situations.

The Plans and Designs as also the funding pattern must also take into account the sewage farming and gas generation and energy recycling potentialities where feasible.

Provisions for 24 hour supply where feasible, is opposed by operational staff out of inertia or out of fear of something going wrong. If the whole network is designed or can be easily remodeled for a 24 hour supply, considerable saving in water and also further in some capital and operational cost as has been reported in cities where it has been done. The pipe sizes will be less and reduction in leakage due to ease in locating those and better operation, reduction in daily control operations and reduction in pollution and water-borne diseases are also considerable advantages. The Planning and Designing stage must therefore explore this possibility and also make suitable provisions to avoid the possible difficulties in such a supply arrangement particularly in the network design and reservoirs etc.

The detailed designs and estimates, in any case must be based on economical solutions and therefore economy available in use of material, new methods and techniques of construction and savings due to large scale economy must be utilised in the present situation of growing costs and resource crunch. Where feasible it needs to be insisted that use of cement pressure pipes, new better quality of collar joints for pipes, etc. should be made. Economy of scale should be availed of through large waterworks and high capacity pumps and reduction in the number of pump houses needing less maintenance staff as a perpetual expenditure and in electricity charges etc. Continuous Training Programmes and refresher courses are must at all levels for creating awareness and exchange of ideas and experiences as also spread of knowledge about new and latest developments.

The broad estimates or the detailed estimates made later and the actual costs incurred in a number of projects executed in the recent period and today, seem to be very much in variance. The cost and time over-runs have created several problems in funding, diversion of resources, manpower and material and on the other side, the benefits are not available to the people. Planning and Designing in many cases is not based on sufficient detailing of stages and after envisaging potential difficulties or operational requirements or for want of a co-ordinated approach in matters like land acquisition, civil-mechanical-electrical works etc. Sometimes ancillary but critical works like providing a bridge to carry the pipe line across the river or stream are not taken up simultaneously though envisaged initially and the project suffers very badly. At the Planning and Design stages itself these matters need to be provided also with a detailed programme and arrangements for monitoring the implementation.

Efficiency, Economy and Equity thus have got to be the basis of all such Planning and Designing.

Very frequent periodical refresher courses and threadbare analysis of project experience in all such training programmes as case studies will considerably improve the situation especially if good design cells are created and good interchange of staff and good interaction between the implementing staff and the designing staff take place.

V TOTAL COSTS, FINANCIAL VIABILITY AND ANALYSIS OF SOURCES OF FUNDS

It is absolutely essential that there is a good control and somehow cost-consciousness prevails and necessary efforts are made to make the projects economical and the costs are worked out with good and economical designs. The variations if essential have to be minimal. Good training in cost reduction and incentives for putting into practice and good performance in practice will be very essential.

The financial viability is based on many factors such as contributions as loans, grants, local contributions, and above all cost recovery after completion of projects as also care taken in design to minimise problems which may add to the costs. The financial yield has to be sufficient for repayment of loans, operational and running costs and generation of enough surplus for meeting the costs of needed replacements periodically later. More detailed and thorough analysis in financial terms has got to be made and it is necessary that concerned staff is made aware of these requirements by Training Programmes, Workshops etc.

It would be a good practice if the senior officials in-charge of the execution of the projects meet all the technical officials in periodical workshops and have detailed discussions on technical matters relating to the design and implementation of the projects.

It has been found that in many projects the assumptions about availability or sources of funds do not hold good later and projects run into difficulties. Even committed funds are not available. Some solutions have to be found. Besides the commitments of authorities for the assured resources, the commitment of the implementation authorities is also needed to avoid cost and time over runs and allowing the costs to rise or projects to linger on for various reasons. Some incentives will have to be devised to induce the implementation authorities and individuals to help in avoiding or at least reducing time and cost over runs:

The financing agencies do monitor the progress but in a rather remote and detached manner. They also at times only helplessly watch the slippages in projects in terms of time and cost over runs. It is necessary that funding agencies like World Bank, LIC, other Banks, HUDCO, Government at various levels and implementation agencies sit together and devise some formula for minimising these over runs and increased needs of funds.

VI GENERAL SCRUTINY & CLEARANCES, AND ADMINISTRATIVE AND TECHNICAL APPROVALS

Some mention about the need for quicker clearances at the initial level has already been made. Even at later stages of technical sanctions, approval to tenders at various stages of construction or purchases of equipments, the reference to higher level officials/committees, state and central governments or even World Bank, several approvals are needed. Sometimes the Reserve Bank Clearances also seem to be taking time. At the instance of World Bank a provision was incorporated in the Bombay Municipal Corporation about deemed approval of the Standing Committee but at the time of payments also the delay can still take place. Though similar provisions are needed to cut down delay in approvals, a thought is necessary as to how the other delays in getting clearances can be minimised.

Some training to project appraisal staff and prescription of standard and concise formats for submission of project details for the scrutiny are also necessary.

It is also necessary to review the procedures and power or authorities for sanctions/clearances. Having given certain overall targets and clearances, perhaps stagewise reporting rather than clearances would be useful.

VII PRIOR PREPARATIONS

Several types of prior preparations are necessary and some checklists need to be prescribed for check up before giving final clearance and starting the project. Some points are listed below:-

i) Detailing of activities and project schedule in the form of lists of all activities and bar charts and networks if a more complicated project is taken up:

ii) Land Acquisition or transfer of govt. land, steps taken and schedule of availability of land as per the requirements of the project (steps to amend some legislations to expedite land acquisition proceedings as are available under MIDC and MHADA Acts in Maharashtra may be needed in other laws and provisions for negotiated acquisition under Land Acquisition Act through a high level official committee should also be availed of):

iii) Schedule of fund requirements as per the expected activity completion schedule of the project also needs to be drawn up and endorsed by the project funding agencies in case of large projects funded by number of agencies including government:

iv) Procurement and supply schedule of needed equipments including major items of steel, cement, pumps, feeder lines & transformers (both to the power supply authorities where needed) also need to be prepared in case of large projects:

v) Commissioning Schedule of various components of the project and steps for co-ordination in various Depts, Agencies and Authorities etc. also need to be drawn up in advance and vetted by all concerned:

vi) Manpower planning for needed staff requirements at various stages of the project, including commissioning, will also have to be undertaken. The responsibilities and relationships of consultants if any and staff also need to be fixed in advance and training of internal staff for taking more effective and appropriate decisions efficiently will also be needed:

vii) Pre-qualification of consultants and of contractors and appropriate terms of references and contract documents encouraging timely completion and ensuring encouragement to cost reduction rather than escalation will also be necessary. The provision of the escalation clause need to be reviewed to make more stricter rather lenient to promote efficient working rather than benefitting by delays;

viii) All investigations and site preparations should also be planned and completed at appropriate stages required by the project.

Prior training of all concerned and periodic sharing of experience by all those concerned with the decision making and implementation seems to be the crux of the problem.

VIII IMPLEMENTATION PROCESS

The main causes of delays in the phase of implementation may be other reasons mentioned earlier such as lack of prior preparations etc. but the main causes of cost and time over runs also seem to be in the process of implementation itself. Monitoring as an important aspect is discussed separately but some general aspects of implementation process are discussed here.

Watching the performance of the contractors, ensuring continuous supply of material, effective control on decision making process including examination of consultants advice, training of internal staff for improving their knowledge and skills as also judgement capacity in respect of the recommendations of the consultants on the basis of organisational requirements and financial implications as also cultivating enough boldness to withstand various types of pressures and quicker decisions, use of effective machinery for removal of encroachments or other hurdles, strong and commanding abilities for effective co-ordination and managerial tact etc. are very important for the process of implementation. Some other practices will also be relevant and important for the over-all progress of the projects such as Pre-audit instead of post-audit, timely release of payments to contractors, including the provision for partial releases, if some points need clarification, instead of holding up the entire bill etc.

IX MONITORING FOR FINANCIAL & PHYSICAL PERFORMANCE AND CRITERIA FOR EFFICIENCY & DEFICIENCY ANALYSIS

The Bar Charts and the CPM/PDM Networks are now known to all implementation agencies and staff, still their actual use in practice is limited, many times, those are used only for filling in the relevant dates of actual achievements at various stages. Their real use is not made for critical reviews and initiating steps to keep the project under control and optimise the use of resources and manpower (even that of contractors and consultants) and follow the time schedule of critical activities without upsetting the costs.

Financial agencies and controlling authorities at the highest level must start worrying and must initiate steps once they notice that the time schedule and costs are being exceeded. When World Bank finances certain projects and limits its share to the originally agreed amounts only, it is also necessary for the Bank to raise questions about over runs because the other borrowings even diversion of internal resources are ultimately going to affect the finance and repayment schedule and the success of the project and image of the implementing and funding agencies.

It is also necessary to develop a suitable Project Management System (PMS) covering all aspects of arrangements for execution and monitoring of projects. The reporting formats for all levels have to be designed in such a way that precise and minimum information absolutely needed to that particular level is easily and quickly available for the relevant decision-making process. It is observed today that many irrelevant details are prescribed in the formats and have to be filled up. It is like asking for many irrelevant questions including the birth date on a format for a casual leave application. The important point in that situation is a person wants a casual leave, the authority wants to know before deciding, whether the person can be spared and there is nothing urgent required from him or her and has to see that the casual leave is not too frequent and is within the prescribed limit.

The formats for reporting the progress of the project in physical and financial terms at various levels can be appropriately designed for each project in its own perspective, levels and types of authorities from officers in the field to the controlling and funding authorities such as government and World Bank if it is in the picture. It is possible to design the formats and reporting graphs (as are quickly drawn with the help of computers in 'LOTUS') for taking a note of financial and physical progress in figure, percentages and bar charts, just by filling relevant figures in the prescribed columns in which targets are already filled in.

The other important aspect is what do the authorities do when the formats duly filled in are received? Do they initiate any actions for encouraging or rewarding good progress and initiate steps for controlling further slippages if those are noticed. Are there any other actions, warnings, punishments for bad performance etc. or the matter is just noted. The present practice of restructuring the project, once some difficulties are noticed may be good in one way but it also deprives some beneficiaries as per the original design and at times are only to safeguard the financial interest of the lending agency and some of the items are left hanging and to the mercy of original controlling authority to go on begging for funds for completing those items and complete those items to see to it that the investment already made is not wasted.

X OTHER RELATED MATTERS

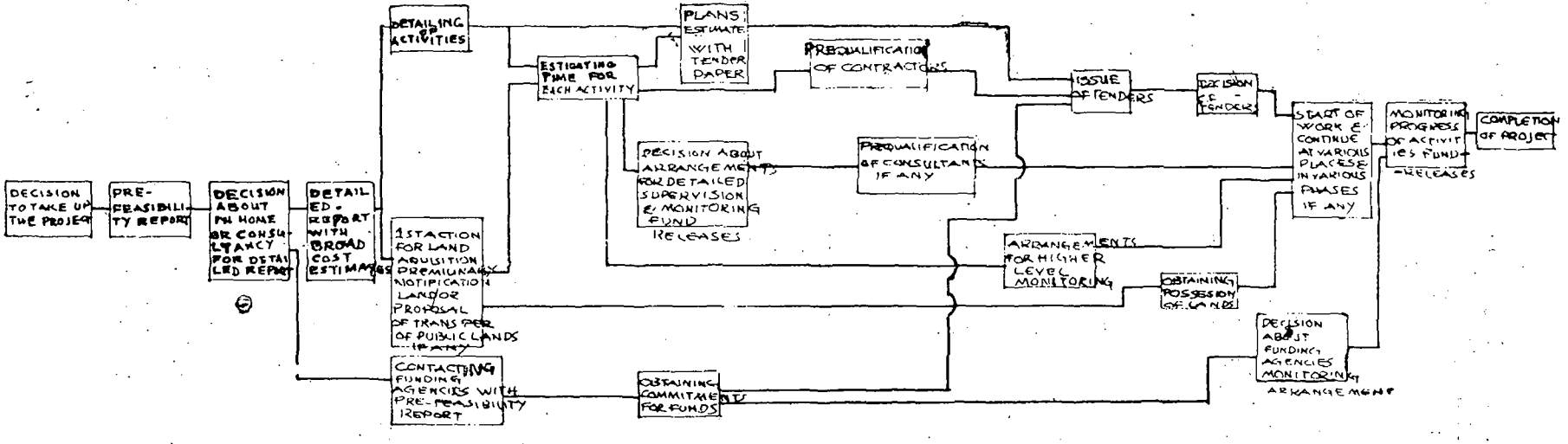
The involvement of concerned local authorities and permitting the larger municipal bodies to take up their own projects by strengthening them with technical and managerial staff and minimising expenditure on establishment or ETP charges, especially in large projects, is very essential. This is also important for the economy as a whole and for optimum utilisation of available scarce resources and using the same for an all-round progress without diverting those from other essential items locally needed. Judicious use of consultants and internal staff, building up staff strengths for further work through project experience are important. Development of Information System alongwith project implementation is also very important. It is observed that maps and relevant technical details are supplied to the operating and maintenance agencies when the projects are completed. Even in case of recently developed projects, just after a couple of years, nobody is able to locate pipelines and their other technical data for taking up routine works or improvements etc.

XI CONCLUDING REMARKS

Several issues concerning Project Management and Financing of water Supply and Sanitation Projects and the experience of such projects in India and the steps needed to be taken are discussed in this presentation.

Project Management experience and development of PMS as also good Training in various aspects of Project Management and Finance as also Operation and Maintenance of the assets created are very important activities and need considerable attention of all concerned. □

PROJECT MANAGEMENT PRECEDENCE DIAGRAM FOR ACTIVITIES.



Advances In Water Treatment Technology

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INTRODUCTION

Appropriate Water Treatment Technology now receives the attention of practically all water authorities and even the smallest of towns have earmarked plans for receiving treated water which till some years ago was unthinkable. In many cases World Bank finances and bilateral aids are also made available for this purpose.

SOURCES OF WATER

Raw water for feed to treatment plants are generally from rivers or lakes. Water from river source due to the turbulance created by the flow generally has a high turbidity value which would be around 200 to 300 mg/l except monsoon seasons when it could go upto 3000 mg/l or sometimes even more.

Water from lakes due to being impounded will have lower values of turbidity generally around 100 mg/l except in monsoon when it could go upto 500 mg/l.

PUMPING

First stage of the water treatment system consists of transporting the water from its source to the treatment plant. The pumping stations are installed often with an intake well. Adequate care by way of proper intake design is taken to ensure that sand is not sucked into the pumps during lean seasons.

AERATION CASCADE

The pumped water is generally let into an aeration cascade where any iron present in the water is oxidised in presence of the alkalinity and atmospheric air and precipitated as ferric iron. Dissolved gases present are also vented out. This is done by increasing the surface area of the water flow thereby increasing its area of contact with air which helps in oxidation.

Normal design practice is to provide an area of 0.45 to 0.65 l pm/sq./day of cascade area. If natural alkalinity is inadequate lime is added in stream ahead of cascade. Three or four steps are provided in cascade to enable the water to fall freely. This enables air-water contact.

FLOW MEASUREMENT

Next step usually is to provide for measuring the flow. The most widely followed method is the installation of a Parshall Flume coupled with a flow indicator, Integrator and a recorder as may be required.

Among the objectives of water treatment is the removal of:

- 0 Turbidity
- 0 Harmful bacteria and other organisms
- 0 Colour
- 0 Taste and odour
- 0 Iron and Manganese

Innovation have come up over the years both in coagulation and filtration, which incidentally are the work horses of the water treatment industry for the past century. New processes will be developed to improve water quality as treated water turbidity standards and goals become more stringent.

We propose to briefly touch on some of these areas, viz.

- Micro Strainers
- Tube settlers or Tilted Plate Separators
- In-depth Filtration
- Water softening combined with Recarbonation. Anthracite in Filtration.
- Conventional Water Treatment Practice Vs Kardile Simplified Filters.
- Ozone Treatment
- Reverse Osmosis
- Telemetering System

MICROSTRAINERS

The goal of filtration is the removal of particulate matter. The types of filtration processes can be in two categories:

0 Surface Filtration Devices including
- Microscreens
- Diatomacious filters
- Slow Sand Filters
- Rapid Sand Filters

0 Indepth filtration devices-Granular media filters.

MICRO SCREENS OR MICRO STRAINERS

These are mechanical filters which consists of horizontally mounted drum, the cylindrical portion of which is made up of special metal fabric and roating slowly (33 M/min). The drum is submerged upto 2/3 and the loading rate is in range of 290 CUM/HR/SQM of filter surface. The solids are retained on inside of rotaing screen and are washed by pumped strained effluent (3-5% of filtrate.)

Very often used for Algae Removal and for Tertiary Treatment.

INCLINED PLATE SEPARATORS

These contain an array of inclined parallel corrugated plates which present a large effective separation area providing a more compact and efficient design. The shallow depth settling principle was first proposed by Hasen in 1904, but later developed by Culp, Hasen, Conley and Yao as late as 1968, 1970.

The tube settler/shallow depth settling concept offers a theoretical sound basis for operating clarifiers at surface loading rates substantially (2-4 times) higher than in deep conventional basins.

The steeply inclined tube settlers inclined at angles excess of 45 deg would not accumulate the sediments. This helps in sludge removal. However, the physical limitations imposed by these requirements limited the practical capacity to plants of 4.5 MLD or less in capacity. Package steel plants are available for tertiary plants in this capacity. The settling tube modules can be also installed in horizontal or rectangular clarifiers for upgrading these units provided the hydraulics permits.

As Tilted Plate Separators (TPS), they are used extensively for oil/water separation in refineries, fuel depots, power stations, petrochemical plants, etc. Gravity separation, by which the difference in density is used to separate the oil globules from the effluent stream. Any sludge associated with the oily effluent slides down the troughs of the plates to the sludges compartment.

INDEPTH FILTRATION

The normal method of filtration downwards through a stratified bed with the finest particles at the top is clearly inefficient since most of the material is removed at our very near the surface of the bed.

The use of a down flow filter comprising two media is however beneficial. A bed composed of a layer of anthracite (1.25-2.5)mm which is less dense than the lower layer of 0.5 mm size has the advantage of presenting large bed particles to the feed first. The advantage of indepth filtration by dual or three media filters can be achieved at lower capital and operating cost the conventional rapid gravity filters.

Such filtration will operate at a much lower head loss than a sand filter of the same overall depth at same hydraulic loading and without determination in feed quality.

Filter runs can be terminated by one or more of the following criteria:

1) Terminal head loss
2) Duration of run
3) Filtrate quality

Whichever method is used, complete automatic operation of filters is possible.

The head loss across a filter bed increases during the run and by incorporating a flow controller to compensate for the increasing head loss in the bed, the total head loss across the unit will remain constant.

Alternately it is possible to operate filters on a declining rate basis with a constant head or obtain constant output by allowing the inlet head to increase as the run proceeds. The complexity and expense of flow controllers can be thus eliminated.

ANTHRACITE IN FILTRATION

While searching for an alternate medium to silica and quartz sand, anthracite was experimented with in Pennsylvania (USA), available from the river coal dredged from the streams. Data collected over the years from 1930 showed that hard coal of the correct hardness, fraction content, size and shape had positive advantages over any of the other media.

Anthracite weighs approx. 1/2 as much as sand and had less loss due to attrition. Tests on a ten year plant operation, shows very little change in particle size or loss of filter medium. Filter runs are longer which means half the filter wash normally required for sand and time out of service is cut in half. Half the backwash velocity is required for 50% expansion and high filter rates are possible without sacrificing quality of effluent.

Anthracite is not easily available in India, of uniform grade and quality. Hence crushed coconut shell media has been used successfully as a coarse medium in Dual Media Filter Beds in Maharashtra during the past decade and more.

Existing Rapid Sand Filters can be converted to Dual Media beds by removing the top 15 to 30 cms of the fine sand and replacing by coarser media of coconut shell or anthracite. This is equivalent to capping the sand filters. This increases the rate of filtration by 50%. The length of filter runs are improved 1.5 to 3 times. The plant capacities are thus upgraded.

SIMPLIFIED FILTERS

These were built at Ramtek (1973), Varangaon (1977), Chandoin (1980) for rural water supply schemes in Maharashtra to the designs of Dr. Kardile of MERI.

RAMTEK (2.4 MLD) incorporates Gravel Bed Prefilters as Pretreatment followed by simplified Dual Media High Rate Filters in place of Rapid Sand Filter Beds. It can occassionally handle turbidity upto 1000 JTU. Only hard backwash is adopted for the filter beds while prefilters can be cleaned by gravity desludging operation. The crushed coconut shell has been used as top coarse layer over the fine sand. This plant was successful and built at cost of Rs. 1.3 lakhs which is 1/3 conventional plant cost.

VARANGAON (4.2 MLD) incorporates unconventional high rate treatment with baffle mixing channel, two units of gravel bed flocculation, two units of setling tanks and three units of dual media filters. Tube settlers were PVC square tubes 50 mm x 50 mm. The filters had declining rate control.

Actual cost is Rs. 4.2 lakhs which is about half the cost of conventional plant.

At many existing Municipal treatment plants, there is possibility of adopting these low cost new techniques to upgrade the plant.

OZONATION

Ozone treatment of water in place of Chlorination is gaining favour in Europe. They reduce taste and odour and the organic content as well as bacterial and viral contents can be reduced by ozonation. Ozone has to be produced at point of usage by electrical production techniques.

Air is dried and compressed and is forced through a chamber where it is exposed to corona discharge from dielectrics. This produces a 1% concentration by weight in air. An air flow of 43 cfm produces 47 lbs of ozone per day. The power required is 7.5 Kwhr per lb of ozone produced and 4 Kwhr/lb for air treatment. An operating PH of 6-7 is recommended as optimum and a total contact time of 20 minutes. However, no residual as in chlorination is possible in the treated water.

REVERSE OSMOSIS

The Reverse Osmosis plant produces desalted water from brackish water or sea-water by forcing water through semi-permeable membrances at high pressure. The process reverses the normal osmotic process by increasing the pressure on the concentrated side of the membrane until flow takes place to the dilute side. The water has to be pretreated to remove all particulates of 30 micron and more. Cellulose acetate membrane for brackish water and Polyamide membranes for sea water desalination are used.

Removals of 95% of TDS, 99% of Phosphate, 60% Nitrate and 96% COD have been obtained in tests. The reject is brine solution which may be upto 20% of volume treated for brackish water. The cost of water produced are relatively high-viz. Rs. 20 per Cum water for brackish water.

TELEMETERING SYSTEMS

A TELEMETERING System allows an operator to monitor or control a remote facility from a central location. Remote reservoirs, pumping stations and flow meters are commonly monitored with telemetering facilities if these are kept unattended.

TELEMETERING call for a transmitter, receiver and a channel (link) between them.

The factors to be considered in selecting a TELEMETERING System are:

- The degree of complexity required. This again depends on information sought and the signals to be transmitted.
- The personnel who will use the system and their training/knowledge.
- The capital costs and the annual operating and maintenance costs.
- Any anticipated changes in the water system and how it will affect the telemetering system.

Generally the more sophisticated the system, the more expensive it is to build and operate. However, depending on other factors the costs may be justified. For instance a monitoring system which just indicates whether or not a remote facility is operating properly will require fewer signals than an automatic or remote control system. These are few types of TELEMETERING Systems available:

1. Owner owned cable
2. Leased telephone cable
3. Radio

The telephone cable leased, is the most commonly used, as the telephone company maintains it and you have to only pay the telephone bill.

Radio systems use radio signals using micro wave and short wave frequency modulation (FM).

The owner owns the entire system and the system is interference free. Major metropolis can efford to go for this as it can be used to communicate large amount of data.

However for smaller municipalities, a leased telephone system may be the answer due to the lowest cost and its trouble free system.

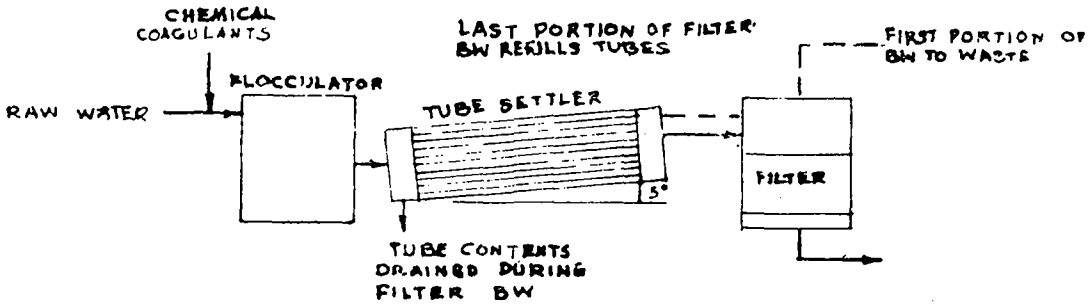
WATER RECLAMATION

Increasing demands for water will in the future require the development of new sources, some of which will contain water of quality inferior to established upland sources. For instance, abstractions from lowland rivers are likely to contain significant proportions of sewage effluents and industrial waste waters.

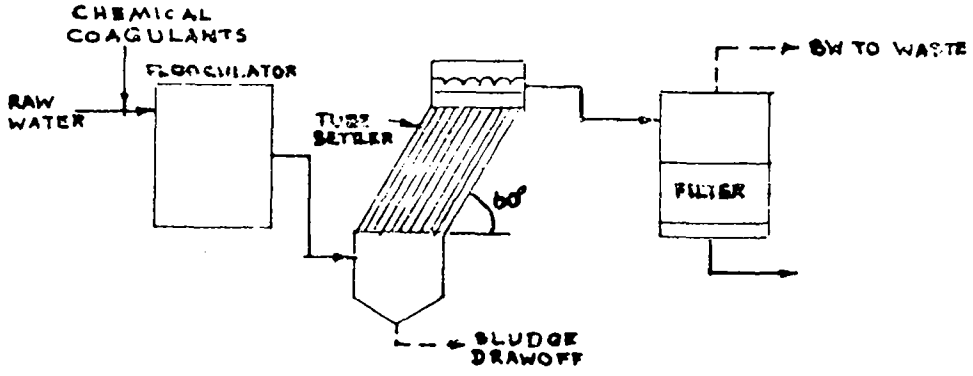
Hence additional processes mainly physico-chemical are needed. □

WHAT IS LIFE ?
A life is a
Challenge .....Meet it
Gift .....Accept it
Sorrow.....Overcome it
Duty.....Perform it
Game .....Play it
Song.....Sing it
Promise .....Fulfil it
Puzzle .....Solve it
Love .....Enjoy it
Beauty .....Praise it

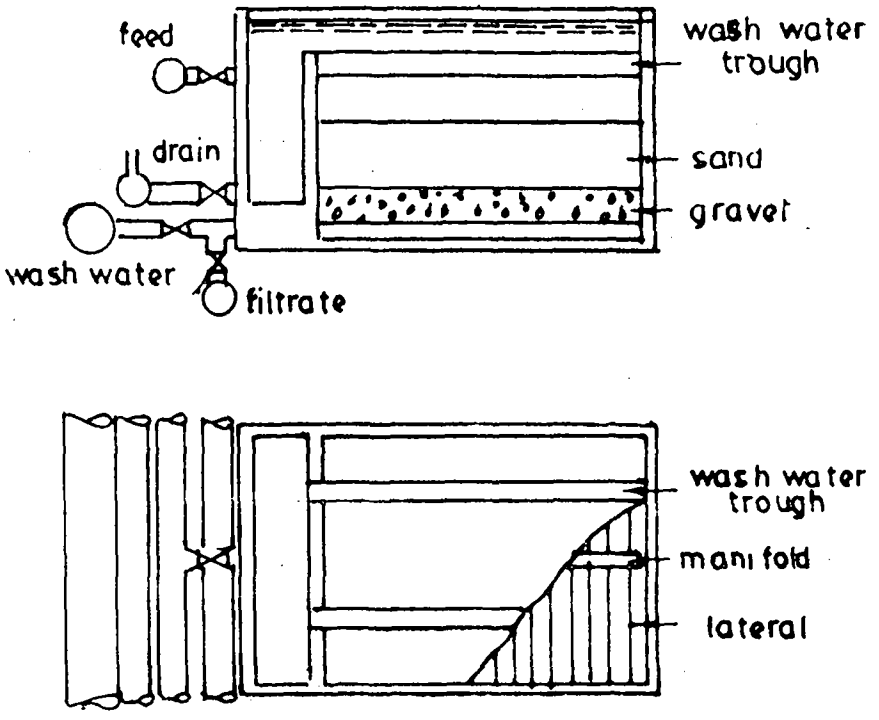
SEDIMENTATION



(A) ESSENTIALLY HORIZONTAL TUBE SETTLER



(B) STEEPLY INCLINED TUBE SETTLER



CONVENTIONAL RAPID GRAVITY FILTER

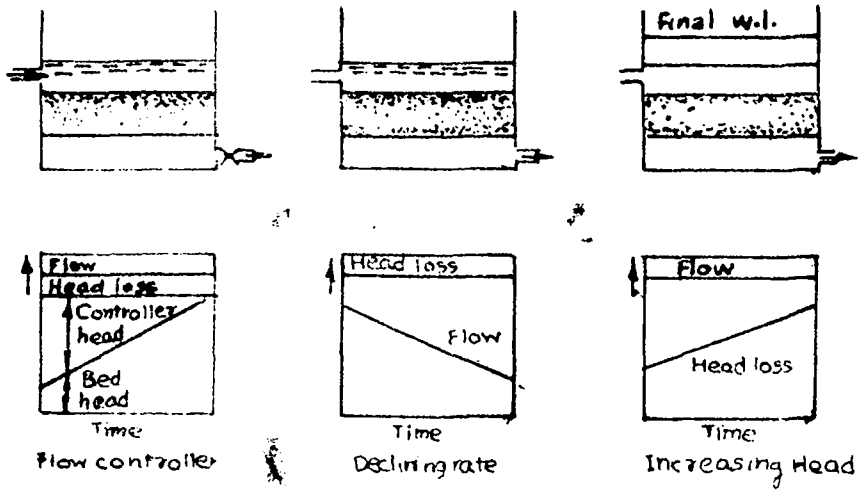
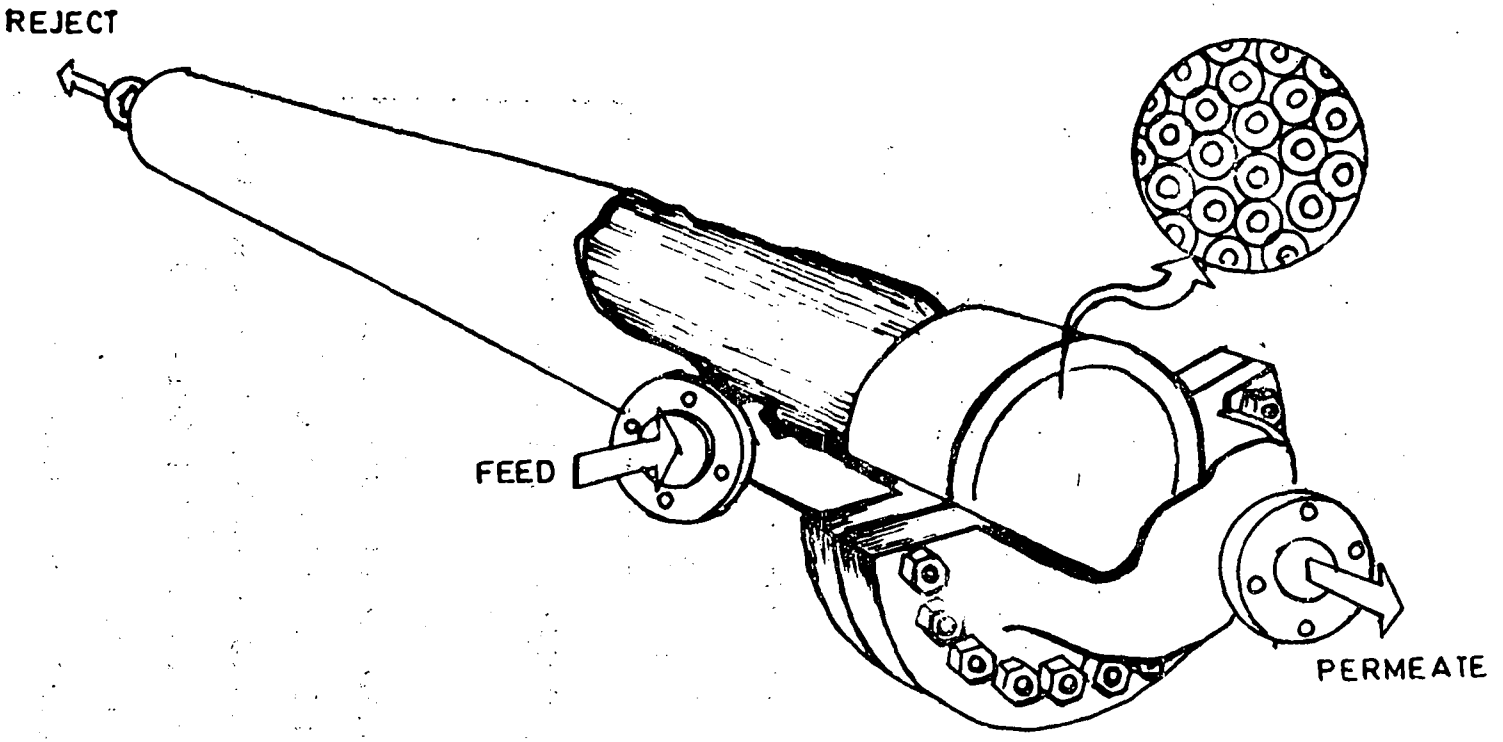


FIG. 11.5. Rapid filter control techniques

DESCRIPTION OF TECHNOLOGY

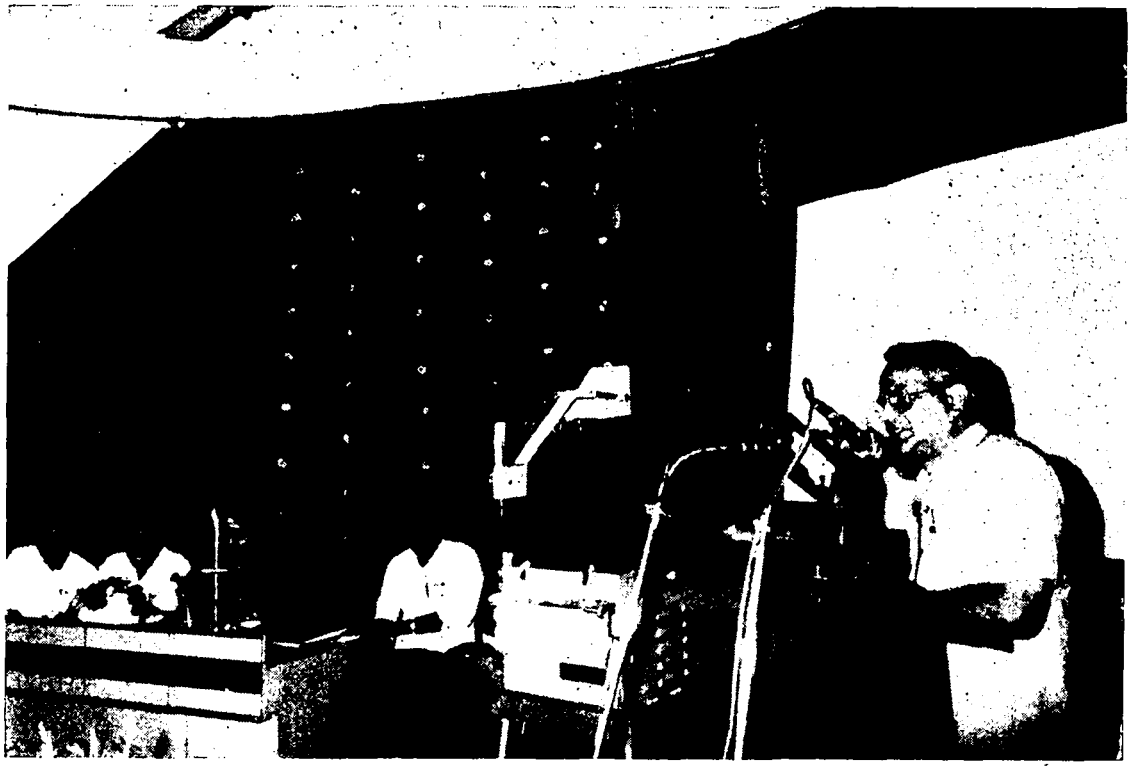
- ★ CHEMICAL CLARIFICATION
- ★ AMMONIA STRIPPING
- ★ RECARBONATION FOR PH CONTROL
- ★ BREAK POINT CHLORINATION
- ★ FILTRATION
- ★ CARBON ADSORPTION
- ★ REVERSE OSMOSIS
- ★ DISPOSAL OF SOLIDS REJECTS



REVERSE OSMOSIS EQUIPMENT EMPLOYING THE HOLLOW LIBER CONCEPT (COURTESY DUPOINT CORP)

	SEWAGE (PARTIAL TR)	AFTER TTP	AFTER RO
TDS	2000 Mg/L MAX	No CHANGE	400Mg/L
TH	500 ,,	150 Mg/L	100 ,.
Ca	280 ,,		
Mg	220 ,,		
NH_3 as N	60 ,,	<5 Mg/L	0.15 ,, (< 1)
SILICA (SiO_2)	40 ,,	20 Mg/L	10 ,,
BOD	120 ,,	<5 Mg/L	2 ,,
TOTAL PO_4	50 ,,	<5 ,,	<1
pH	7-7.5		7.5
χ AIK	600 ,,		

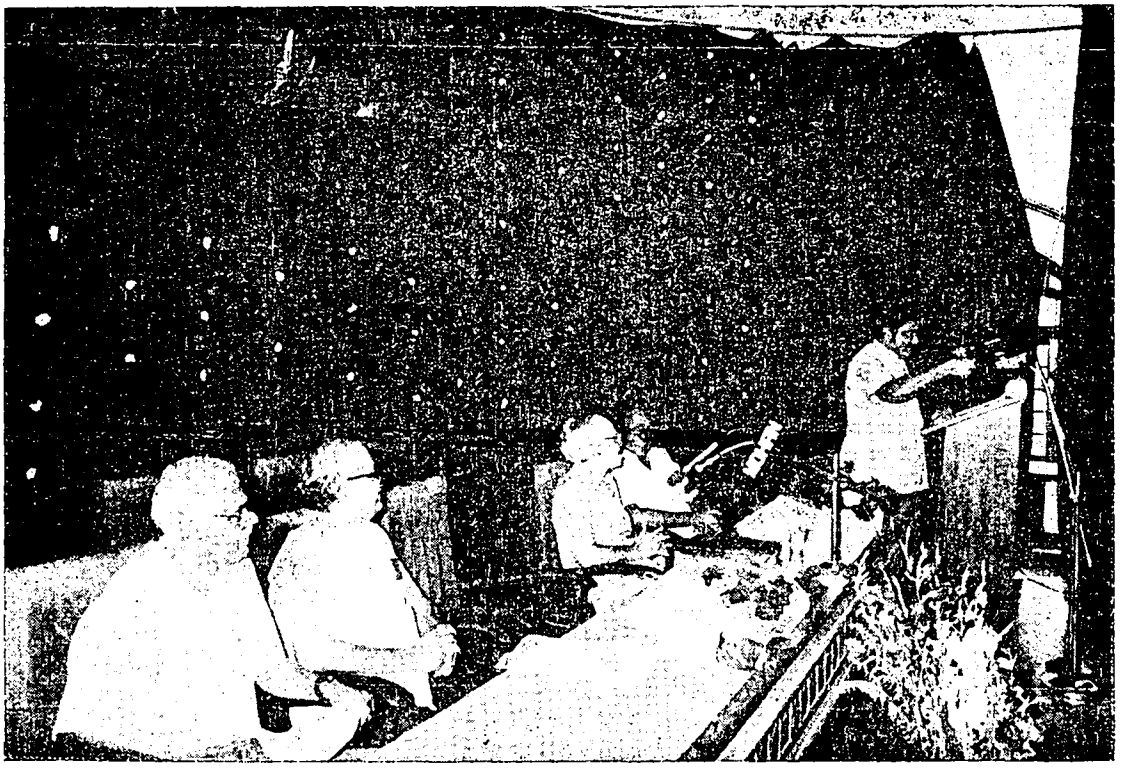
TECHNICAL SESSION -3 GENERAL



Sri. V. B. Ramaprasad, Dy Adviser (PHE), CPHEEO Presenting his paper during technical Session 3

Rapporteurs of the various Sessions finalising the recommendations of the Seminar.

The Chief guest Sri. I. S. Gulati (Vice Chairman, State Planning Board), Sri. Babu Paul I. A. S., Chairman, Sri. K. Padmanabhan Nair, Managing Director and Sri. R. Unnikrisnan Nair, Technical member, KWA on the dias during the valedictory function



Sri. Babu Paul I. A. S., Chairman, KWA addresses the delegates during the valedictory function

Cost of Borrowed Capital For Water Supply Systems

Sri. S. S. SRINIVASAN,
Chief Engineer,
Madras Metropolitan Water Supply and
Sewerage Board and
President, Indian Water Works Association.

Borrowed capital has been recognised as the prime source of funds for reaching the coverage targets for water supply systems in our Country, since the local bodies do not have sufficient internally generated resources for bulk investments. Repayment of borrowed capital is through part utilisation of revenue, collected by tariff and taxes. This revenue has also to take care of operation and maintenance and depreciation in addition to debt servicing. Sample records of certain cities indicate that debt servicing form a sizeable component of the annual expenditure for a typical water authority. For example, for Madras Water Supply System debt servicing varies from 18.40% to 20.60% of the total revenue expenditure for the years 83-84 to 85-86. Similar figure for Jaipur Water Supply System is quoted as 13.89% for 85-86 (Srinagar Seminar on Water Tariff, 1986).

1. The cost of borrowed capital is, therefore, of recognised importance in ensuring financial balancing of any water supply system.

2. Return from investment on water supply systems has its own characteristics as listed below:

i) The construction period for any semi-urban or urban system is more than 24 months and return from the investment commences only after the total Project is completed and consumers also start drawing their connections. Thus revenue generation becomes possible only after a few years from loan drawal and hence moratorium for repayment is absolutely necessary.

i) The number of connections increases with the passage of time due to increase in population and this contributes to larger revenue in later years. Extended period of repayment of loan would therefore be beneficial to the water authority.

2.2 Water Supply Systems require periodical upgrading to cater to increased demand and the optimum timing of upgrading could coincide with the life of the present project. In other words, any water supply system would require periodical upgrading once in every 30 years. In this context, it will be appropriate if period of repayment of loan merges with the life of the project i. e. 30 years since the water authority will have no outstanding liability while planning for new investment.

3. With this background, it is proposed to analyse the factors which affect the cost of borrowed capital and also the terms of repayment which are acceptble to the lender and also affordable to the borrower. It is worthwhile in this context to have a resume of the lending policies of certain financial institutions for water supply sector.

4. Presently, two funding agencies in the Country have been advancing loan to water supply systems. Housing and Urban Development Corporation Ltd. (HUDCO) and Life Insurance Corporation Ltd. (LIC). While HUDCO mobilises its resources for lending by borrowing from financial institutions and Bonds, LIC utilises its own resources collected through premium of the insured for investment in water supply and allied sectors. Again LIC adopts two differential rates of interest (i) investment of specified amount within the plan provision and at nominal rates of interest and as per terms and conditions prescribed by the Government of India as a statutory social obligation and (ii) additional investment outside the plan provision at terms and conditions prescribed by the LIC at a higher rate of interest.

In addition, a good number of States in our Country have been the beneficiary of loan assistance from the World Bank. This loan assistance is operated through two agencies (i) a soft loan by International Development Association (IDA) and (ii) a normal loan by International Bank for

Reconstruction and Development (IBRD). The loan is always a blend of the two and for a developing country like India, the blend has a higher component of IBRD for water supply sector.

Thus investments on water supply systems are made available through the following lending agencies as per terms and conditions specified therein:

	Rate of Interest %	Period of Repayment Yrs	Moratorium Yrs
HUDCO	15.0 *	12	3
LIC (under plan)	10.25	25	3
LIC (outside plan)	14.0	25	3
World Bank (IBRD)	8.75	20	3

* For cities of population more than 10 lakhs.

5. Thus the cost of borrowed capital depends on three variables (i) rate of interest, (ii) period of repayment and (iii) moratorium. It is now proposed to work out an academic exercise to bring out the effect of these variables on the cost of borrowed capital and arrive at a common base of comparison of these variables.

6. The following basic data have been considered for a typical analysis:

1	Total loan amount	Rs. 100.00 crores
2	Drawal of loan year 1	Rs. 30.00 "
	year 2	Rs. 50.00 "
	year 3	Rs. 20.00 "

Applying the respective conditions of lending by the lending agency as listed in para 4 above the interest commitment and the principal repayment has been worked out for each lending agency and abstracted in Annexare. These are based on the principle of fixed annuity formula. The annuity is defined by the Constant Annual Payment (R) which will be necessary to repay a loan (P) over a given period of time (n) at the rate of interest (i)

$$R = \frac{P_i (1 + i)^n}{((1 + i)^n - 1)}$$

These annuity payments have been cumulated over the period of repayment and the total amount payable for full discharge of loan is given below in respect of each agency.

Sl. No.	Agency	Rate of Int.	Repayment yrs.	Total repayment Rs. Crores	Base ratio ℓ
1.	HUDCO	15.0 %	12	263.51	1.050
2.	LIC (out side plan)	14.0 %	25	392.96	1.565
3.	LIC (plan)	10.25 %	25	302.15	1.204
4.	World Bank	8.75 %	20	251.02	1.000

ℓ Comparing with the lowest figure (World Bank) as a base figure of 1.00.

7. The above analysis gives an apparent conclusion that the cost of borrowed capital from HUDCO is less than that of LIC eventhough the rate of interest for HUDCO is higher. This apparent conclusion is evidently incorrect as this does not take into account the true cost or the cost expressed in real comparable terms of the total repayment. An appropriate method of working out this true cost will be to assess the present

worth or present value of the total repayment. Present Value (PV) is defined as today's value of a future investment and is expressed by the formula.

$$PV = \frac{p}{(1 + i)}$$

8 The present value has been worked out discounting the future payments at a rate of interest at 10%. Detailed figures find place in the corresponding columns in Annexe and the abstract is furnished below:

Sl. No.	Agency	Total repayment Rs. crores	Prevent value Rs. crores	Base ratio ϱ
1.	HUDCO	263.51	125.70	1.514
2.	LIC (outside plan)	392.96	122.81	1.479
3.	LIC (plan)	302.15	93.85	1.130
4.	World Bank	251.02	83.03	1.000

ϱ Comparing with lowest figure (World Bank as a base)

The rate of interest for discounting has been taken as 10.0% which is the normal rate of interest on deposits from Nationalised Banks. Even if a different discounting rate is taken for computation, the present value may be different but the base ratio worked out in the last column will be the same.

9. The following analysis is interesting:

i) It is normally said that World Bank loans are attractive. It is seen that LIC (plan) loans are only 13.0 % higher than the World Bank loan. Further analysis indicates that if the repayment of LIC loan is extended from 25 years to 30 years (which corresponds to the life of the project) the present value of total payment works out to Rs. 93.99 crores and the base ratio of present worth works out to 1.132. Thus LIC (plan) loans become as attractive as World Bank loans.

ii) HUDCO loans are 51. 4% costlier than World Bank loans and 34. 5% costlier than LIC (Plan) loans. Further analysis indicates that with the same rate of interest of 15·0% for HUDCO the present value of repayment works out to Rs. 139.91 crores and Rs. 142.06 lakhs respectively if repayment is fixed at 25 years and 30 years. Thus extending the period of repayment to more than twice the period increases the present value only marginally but this is highly beneficial to the borrower i e. the water authority, as the annuity is less and hence becomes affordable especially in the initial years when the revenue from water system is also less. As HUDCO funding is based on borrowing from financial institutions, it may not be appropriate for the borrower to seek compromise on interest rate but HUDCO could make the terms and conditions more affordable to the borrower by extending the period of repayment.

10. The following conclusions are evident:

i) Lending terms of LIC (Plan) may be made comparable to World Bank loan if the period of repayment is extended to 30 years. This is a note worthy phenomenon if political policies require minimising the external debts.

ii) As HUDCO has entered in a big way to invest in water supply systems, but with constraints on rate of interest to be levied, the terms and conditions could be made more attractive to the borrower by extending the period of repayment.

These change in policies by the funding agencies could substantially generate more investment in water supply systems and help the Government's policy in reaching the targets.

The authors are grateful to the Chairman and Managing Director of Madras Metropolitan Water Supply and Sewerage Board for the encouragement given and for permission to present this paper. □

ANNEX I

ANNUITY DUES FOR VARIOUS LENDING AGENCIES

(Rs. in Lakhs)

Year	P V Factor @ 10%	HUDCO @ Annuity	15% P V	LIC Annuity	14% P V	LIC Annuity	10.25% PV	WORLD BANK Annuity	8.75% PV
1	0 9091	495	450.00	420	381.82	307	279.09	262	238.18
2	0.8265	1305	1078.58	1120	925.68	820	677.73	700	578.55
3	0.7514	1610	1209.75	1400	1051.96	1025	770.18	875	657.47
4	0.6831	1945	1328.63	1455	993.91	1123	767.12	875	597.71
5	0.6210	1942	1205.98	1455	903.55	1123	697.38	875	543.37
6	0.5646	1938	1094.19	1455	821.49	1123	634.05	1076	607.51
7	0.5133	1933	992.21	1455	746.85	1123	576.44	1076	552.31
8	0.4666	1928	899.60	1455	678.90	1123	523.99	1076	502.06
9	0.4242	1922	815.31	1455	617.21	1123	476.38	1076	456.44
10	0.3856	1915	738.42	1455	561.05	1123	433.03	1076	414.91
11	0.3505	1907	668.40	1455	509.98	1123	393.61	1066	377.14
12	0.3186	1898	604.70	1455	463.56	1123	357.79	1076	342.81
13	0.2896	1887	546.48	1455	421.37	1123	325.22	1076	311.61
14	0.2633	1875	494.48	1455	383.10	1123	295.69	1076	283.31
15	0.2394	1851	443.13	1455	348.33	1123	268.85	1076	257.59
16	0.2176	—	—	1455	316.61	1123	244.36	1076	234.14
17	0.1978	—	—	1455	287.80	1123	222.13	1076	212.83
18	0.1798	—	—	1455	261.61	1123	201.92	1076	193.46
19	0.1635	—	—	1455	237.89	1123	183.61	1076	175.93
20	0.1486	—	—	1455	216.21	1123	166.88	1076	159.89
21	0.1351	—	—	1455	196.57	1123	151.72	1076	145.37
22	0.1228	—	—	1455	178.67	1123	137.90	1076	132.13
23	0.1116	—	—	1455	162.38	1123	125.33	1076	120.08
24	0.1015	—	—	1455	147.68	1123	113.98	1076	109.21
25	0.0923	—	—	1455	134.30	1123	103.65	1071	98.85
26	0.0839	—	—	1455	122.07	1123	94.22	—	—
27	0.0763	—	—	1455	111.02	1123	85.68	—	—
28	0.0694	—	—	1436	99.66	1111	77.10	—	—
		26351	12569.86	39296	12281.23	30215	9385.03	25102	8302.86

@ Marginal changes in Annuity to provide for service charges and commitment charges levied by HUDCO.

Procurement of Materials- Methods And Procedures

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1.0. INTRODUCTION:

1.1 Materials management is a vast subject which has been widely dealt with reference to Industries. But for a multi-outlets and multi-inlets institution like Gujarat Water Supply & Sewerage Board (GWSSB) in particular and any Water Supply Organisation (WSO) in general the problems are different and of diverse nature and the same have to be dealt with accordingly.

1.2 Types of stores required are many. In a WSO commonly used materials are:

a) Various types of pipes viz, AC, PVC, RCC, Pre-stressed concrete, stone-ware, steel (spirally welded, ERW, black, galvanised, etc.), CI, HDPE, Fibre Glass reinforced pipes (FRP), etc;

b) Pumps (Centrifugal, turbine, sub-mersible, etc.);

c) Specials-CI, PVC, Steel fabricated;

d) Valves - Sluice valve, air valve, non-return valve hydrant valve, foot-valve, butterfly valve, etc;

e) Meters;
f) Engines;
g) Electric Motors;
h) Electric Cables;
i) Control Panels;
j) Manhole frames & covers;
k) Chemicals like chlorine-gas & tablets, alum, etc;
l) Drilling tools and equipments;
m) Hand pumps. etc.

All individual type of material has its own classes and sizes and from this it can be understood as to how many items will be there on inventory. More the items, more the problems!

1.3 The different types, classes and sizes having various specifications, capacities, etc. combine together to make the material management of a WSO more complicated and difficult. This presentation is to discuss certain aspects, to pose a few problems and to warn against some of the mistakes committed in the past. It is also intended to be informative with reference to present status in GWSSB.

2.0 METHODS OF PURCHASE:

2.1 There is bulk tender method meant for one time purchase of a fixed quantity. This is resorted to when quantity of material is fixed and is required at a time. Against this there is ratecontract method resorted to when quantity is uncertain but demand is continuous over a period. Here the rates are fixed which remain in force for a specific period-say a year. As and when demand arises, orders are placed with the rate-contract holder who supplies the same within a certain time limit.

2.2 Then there are centralised purchases and decentralised purchases. In a smaller organisation, centralised purchase is desirable. It has advantages of bulk bargaining, uniform and reasonable prices, consistency in quality, vendor control, etc. For odd items in small quantity decentralised purchase is resorted to. To fix up a rate contract centrally and allow field officers to operate the same as direct demand officers is a combination of both systems on which are operated DGS & D and GSPO rate contracts.

3.0 PRE-PROCUREMENT ACTIVITIES;

3.1 Before any procurement procedure is started, certain activities have to be undertaken in order that the procurement is smooth. These are identified in following paras:

3.2 First and foremost of all is to ascertain the type of stores required and the time by which it is required. Technical suitability of the stores is of course to be decided by the indenting officer but the Purchase Officer should take note of any oddness in the indent e. g. unusually big demand, unusual type or size or class of stores indented, etc. Many a times the store is required in stages over a long span of time and such provision in tender can fetch low and reasonable prices. Long delivery schedule can facilitate manufacturer to plan this activity while it will moderate the cash flow of the purchaser. Corresponding storage problems also can be reduced and deterioration avoided.

3.3 Second step is to ascertain the specifications of the stores to be purchased keeping in mind the end use and market prices. Generally, stores purchased are with ISI mark or conforming to a certain IS specification. But many a times it is lost sight of that there are certain options available in the ISS also and the purchaser has to exercise this option while notifying or ordering the materials. For example, in case of ERW pipes the end condition has to be specified as plain, screwed, etc. In respect of market price there is an excellent example of AC pipes vs PVC pipes. PVC pipes are decidedly cheaper in certain sizes and with better flow characteristics. Therefore in such a case the indenting officer has to be advised by the purchasing officer.

3.4 The third step is to ascertain the market availability. Many a times it happens that the store that we want to purchase is just not available in the market. Either the specifications are wrong, the material available does not have ISI mark or material conforming to our specification is just not available. If this aspect is not taken care of, then there will be unnecessary loss of time and effort.

3.5 As a corollary of para 3.4, it is also necessary to ascertain that adequate number of vendors/manufacturers are available in the market so as to have competitive price. If such is not the case, then it is advisable to either go for substitute product or find a way to obtain competitive prices.

3.6 An assessment of lead-time required for each type of store should be available with the purchase organisation. This is the time schedule required for procurement from the day of receipt of indent to the day of delivery. Inventory of various materials to be maintained depends upon the lead time for each of the items.

4.0 QUALITY ASSURANCE:

4.1 Water being essential to life, the water supply system has to be reliable. A reliable system can be the product of quality materials, superior workmanship and adequate supervision. Due to assorted types, sizes and classes of materials used in water supply systems quality assurance in respect of materials to be used assumes paramount importance. The question is how it can be achieved. The following quotation attributed to John Ruskin should be a guiding light for all materials managers: "There is nothing in this world that a person cannot manufacture a little worse and sell a little cheaper and a customer whose sole criterion is price, becomes a legitimate prey of such a person".

4.2 There are two types of stores from quality point of view. First is a monolithically manufactured goods like pipes, steel-bars & plates, specials etc. Second type is assembled items like engines, motors, pumps, valves, etc.

4.2.1 In case of monolithically manufactured goods quality can be assured by specifying raw materials and laboratory performance tests designed on the basis of field conditions in which the material is to be used. For established manufacturers and processes sample testing at works, ISI marking etc. will be adequate to ensure quality.

4.2.2 In case of assembled items, the quality assurance is more difficult and complicated. The testing has to be more rigorous, broad

-based and performance oriented. It is found to be more fruitful to resort to vendor-evaluation for the purpose of pre-qualification. Vendor's capability to produce quality goods is first established taking into account their manufacturing capability, testing facilities, quality control organisation and procedures, raw material procurement and testing, quality control of bought-out components, etc. Once certain parties are pre-qualified, the tenders are issued to such parties only. Subsequent testing of finished goods, adequately assures quality. All performance problems have to be taken care of by defects liability and warranty.

5.0 INSPECTION:

5.1 Inspection should actually form part of "quality assurance". But it is a subject by itself and hence it is separately dealt with in this presentation. Inspection is the last activity to ensure quality in procurement procedure. Inspection can be departmental or through third party.

5.2 Departmental inspection will be expeditious and cheap but will tend to be slack and casual. It will be non-responsive also because the inspecting officer himself will be the consumer and is not in anyway answerable to anybody else.

5.3 As against departmental inspection, the third party inspection will be costly, as inspection fees will have to be paid and may be more time consuming because all the formalities like payment of inspection fees, sending inspection call in a formal way by the vendor, etc. have to be followed. But the third party inspection will certainly be more stringent and consistent and it will be certainly responsive as the third party is answerable to the purchaser for any quality problem which may subsequently arise in the field. For quality assurance, it is desirable that a professional third party inspecting agency is engaged.

6.0 TENDERS:

6.1 As regards tender procedures followed by GWSSB is concerned, certain policy decisions have been taken and terms and conditions have been standardised which can be helpful in getting reasonable price at uniform terms and conditions. Same can be enumerated as under:

6.1.1 It was decided to include price escalation clause for rate-contracts spanning a period of one year to take care of the increasing prices of the raw-materials wherever a standard escalation formula is available. This was done with an intention to ensure a reasonable price devoid of an element of speculation about the probable future increase.

6.1.2 Another policy decision was to allow the taxes and duties as per actuals as applicable from time to time so that the vendors are insulated against the statutory increase (or decrease) in taxes and duties.

6.1.3 The Board decided to purchase materials from the original manufacturers only which will ensure not only competitive prices, but also quality assurance, as the name of the manufacturer will be at stake if any quality problem arises in the field. The Board can use the lever of black-listing the manufacturer also which will affect them to a great extent and will be a major deterrent for them to relax or by-pass their quality control procedures.

6.1.4 It was decided not to allow negotiations with any party at a stage prior to taking a final decision. This was with an intention not to allow any canvassing or in any other way affecting the decision of the Board. For this purpose it is absolutely necessary that for all the tenders there must be a pre-bid conference of the vendors to sort out any problem, ambiguity or uncertainty as regards tender documents to which they have to conform while submitting their tenders. Once all the points raised at the time of pre-bid conference are taken care of and decided, the vendors to be responsive, have to submit their tenders completely in conformation to the tender documents.

6.1.5 As regards the clause of time limit, it was decided to be more realistic and the penalty clause has been converted into a clause of liquidated damages. A reasonable force-meajure clause was also incorporated as an attenuating clause for the time limit prescribed in the tenders.

6.1.6 The tendering system is adopted as a so-called two-cover-bid system. In this system, the vendors have to submit their tenders in two separate covers; one containing the specifications, terms and conditions etc. while the other cover containing the price-bid. While opening the tenders, the cover containing terms and conditions and technical specifications is opened first and if the tender is found conforming to the Board's requirements, then only the price-bid of the tender is opened. If there are deviations in the terms and conditions and/or specifications, the tender is treated as non-responsive and the price-bid of that tender is not opened at all. As a result of this system, it is found that a sense of discipline is slowly appearing among the vendors/manufacturers of various items.

7.0 NEW FEATURES FOR RATE-CONTRACT:

7.1 Previously while fixing up the annual rate contracts, the tenders were quoted and received. The lowest evaluated tender was awarded and the other tenderers were asked to match the lowest price in order to enter into parallel rate-contracts. Such a procedure was followed as no one manufacturer could meet the annual requirement. It was found that the sense of competition among the tenderers was not very much visible as they were more or less certain of acquiring parallel rate-contracts on the matched prices and there was no incentive for quoting competitive prices. Therefore with a view to ensure competition, the following system was introduced:

7.1.1 The tenderers are required to commit a specific capacity per month for GWSSB while submitting their tenders.

7.1.2 After the tenders are received, a comparative statement of evaluated prices after giving due preferences as per Government rules, is prepared and rank numbers are allotted to various suppliers. Lowest evaluated tenderer will rank first.

7.1.3 In the contract agreement, a provision is made to the effect that the supplier at rank No. 1 is assured of an order to the extent of 75% of his committed capacity subject to demand.

7.1.4 If the demand is more, then the balance quantity spills over to the supplier at rank No. 2. He is also entitled to get a minimum order to the extent of 75% of his committed capacity subject to demand.

7.1.5 The allocation is carried on in the same manner according to the ranks allotted to various suppliers in the comparative statement based on the evaluated prices.

7.2 The usual penalty/liquidated damages, clause is incorporated in the tender, but in addition a negative incentive by way of reduction in monthly supplying capacity is also incorporated. As for example if a supplier has committed a capacity of supplying 50 tonnes of material per month and he is given an order for the same quantity for a particular month and in case he supplies only 40 tonnes during the stipulated time limit, his monthly committed capacity stands reduced to 40 tonnes/month for the remaining period of the rate-contract. In this manner he will be continuously losing business for future period of the rate-contract. The visible result of this negative incentive is that the suppliers are making their best efforts to supply the material in time and practically there are no defaults in supply schedules.

8.0 CONCLUSION :

The various improvements in the procurement procedures for GWSSB has been introduced over a short period, i.e. about a year and the real evaluation of the new features introduced can be done after the system is in operation for a reasonable time. However, at present, the system has been working fairly smoothly and there are no major complaints even from the RC holders.

Public Health Engg. Training & R & D Activities of the Ministry of Urban Development, Government of India.

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The Public Health Engineering Training Programme was started as part of the Health plan in the year 1956 and has continued with increasing tempo over the years. Now that the International Drinking Water Supply and Sanitation Decade is on, and skilled manpower would be required in a larger measure than before, it is Ministry's endeavour to meet this challenge by increasing the tempo of the programme. The training provided caters to all categories of personnel to ensure that the training reaches greater number and effects a qualitative improvement to enable them to face the variegated tasks set before them.

In the field of Public Health Engineering, the development of manpower is to be achieved basically in two ways, by improving the number and quality of trained persons at all levels and by appointing categories of persons, where needed, who are in short supply for systems construction and for proper operation and maintenance of the services. At the beginning of the decade, there were about 9,800 graduate engineers and 15,800 diploma engineers in the sector, occupying posts ranging from senior-level engineers to engineers at operative levels. It was estimated that for the first phase of the Decade programme coinciding with the end of the Sixth Plan (1980-85) the requirement would be 18,900 graduate engineers and 30,800 diploma holders. For the second phase of the programme (1985-91) the total requirement was estimated at 28,700 graduate engineers and 52,800 diploma holders. Besides, the availability of technicians has to be increased from the level of 29,200 to 1,27,300.

Keeping these targets in view, a perspective training plan with the following broad objectives has been evolved by CPHEEO:-

(a) To make available engineers and technicians, with the basic qualifications in adequate number and at the right time.

(b) To develop, in the existing personnel adequate conceptual appreciation, technical skills and capacity to motivate people.

(c) To ensure that the technical personnel get abreast of the latest appropriate technical developments, thus guarding against the ever present danger of obsolescence.

(d) Periodical inservice training to refresh current knowledge.

(e) Familiarisation with appropriate low cost technologies, which are specifically suited to the conditions prevailing in the country.

(f) Maintenance & operation of water supply and sanitation systems.

(g) Community participation & Health Education with the objective of bringing about participation of the beneficiaries in the planning, locating and maintenance of the systems.

Different committees in their reports have made various recommendations regarding development of Manpower and expansion of training programme in the field of Public Health Engineering.

i) The 48th report of the Estimates Committee on erstwhile Ministry of Works & Housing for drinking water supply & sanitation.

ii) Recommendations of the Conference of Chief Engineers on Planning for the International Drinking Water Supply & Sanitation Decade.

iii) Recommendations of the Working Group on the Programmes and Manpower set up by the Apex Committee on International Drinking Water Supply & Sanitation Decade programme.

The training programme is catered to 3 categories of personnel in the field of public health engineering viz (1) Graduate engineers being given training in the post Graduate course; (2) Subordinate engineers holding diplomas being oriented in public health engineering through short-term course and (3) Refresher courses tailored to the needs of the senior, middle and junior level engineers and other para engineering personnel.

POST GRADUATE COURSES:

This type of training has been necessitated due to the fact that the entry level qualifications for service in Public Health Engineering Departments/ Boards is generelly Bachelor of Engineering Degree and there could be difficulty in raising this level to that of Post Graduate qualifications.

The Ministry extends stipendary support to sponsored trainees admitted in 10 academic institutions, at present. On an average 100 candidates are trained each year. Annexure-I shows the list of institutions recognised by the Ministry of Urban Development.

SHORT-TERM COURSES IN PUBLIC HEALTH ENGINEERING:

The subordinate engineers in the Public Health Engineering Departments/Boards have a key role to play in all the activities of water supply and sanitation programme. This course has been tailored in such a way that the diploma holders get an exposure towards the finer points of public health engineering so that they can make use of the same in the field. The duration of the course is 3 months and at present being conducted by 2 academic institutions in the country.

The Ministry extends financial assistance for conduct of short-term courses in these institutions.

REFRESHER COURSES:

A very important area of training under the programme has been the refresher courses. These courses are diverse in nature covering all categories of engineers from the senior to the junior level and other para engineering personnel. The list of refresher courses sponsored by the Ministry is given in the Annexure-II.

These refresher courses are financially supported by Government of India and are conducted in collaboration with the State Public Health Engineering Departments/Water Supply Boards and other concerned Institutions.

STATE LEVEL TRAINING COURSES:

The proper operation and maintenance of water supplies is one of the key factors in ensuring a high quality of service to the consumers. The training is imparted to operators, mechanics and other lower level categories of public health engineering personnel through State level training programme. Under this programme, Government of India is encouraging the State and Union Territories to develop their own training centres by providing necessary technical and financial assistance to the extent possible.

TRAINING ABROAD:

In addition, every year several Public Health Engineers and Administrators who are engaged in the field of water supply, sanitation and solid waste management programmes are regularly sent abroad for necessary training with the assistance of WHO and ODA (U. K.).

TRAINING OF INTERNATIONAL CANDIDATES:

Realising the importance of constant exchange of professional ideas and experience, the Ministry of Urban Development has been organising the placements of several international candidates sponsored by WHO, USAID etc. from South East Asia and other developing countries in their respective areas of interest in premier institutions/ agencies in water supply, sanitation and solid waste management sector.

The lack of adequately trained technical manpower is undoubtedly a serious constraint in some States and Union Territories. Therefore, there is an urgent need to recruit more engineers and adequately trained personnel engaged in water supply and

sanitation programme. Keeping this in view, the Ministry of Urban Development in collaboration with WHO (SEARO organised a National Seminar on Environmental Engineering Education, Training & Research, from 13 th to 15 th January, 1988. The objectives of the Seminar were:-

1) To review the Post Graduate Courses of Studies in Public Health Engineering in the national plan for the Decade as well as the current environmental health needs in the country & suggest modifications;

2) To review the present patterns of inservice training for professionals and sub-professionals in the field of PHE & suggest measures to strengthen the same.

3) To review the status and identify priority areas of research & development.

Professors from different eminent technical institutions, research scientists and engineers from different organisations in the country, representatives of different Central Governments Ministries/Departments and Officers of State Governments dealing with Public Health Engineering Training Programme participated in the Seminar. The Seminar provided a forum for discussion and gave an opportunity for professors, Departmental Heads, Central Government authorities and International Agencies to meet together and exchange views and experience and plan future strategies with respect to Public Health Engineering Training Programme.

CANDIDATES TRAINED IN DIFFERENT COURSES UNDER PUBLIC HEALTH TRAINING PROGRAMME OF THE MINISTRY OF URBAN DEVELOPMENT.

Sl. No.	Name of Course	No. of candidates trained (as on 31-3-1990)
1	P. G. Course in Public Health/ Environmental Engineering.	1446
2	Short-term Course in Public Health Engg.	1842
3	Refresher Courses in Public Health Engg.	5145
4	Water Works Supervisors Course.	2063
5	Sewage Works Supervisors Course	105
6	Improved Design Techniques using micro-computer.	102

NEED FOR A NATIONAL TRAINING CENTRE:

There is an urgent need for a National level training institute in the field of public health/environmental engineering under the management of Ministry of Urban Development to train various categories of professionals in technical, financial, administrative and managerial aspects to deal with water supply, sewerage, low cost sanitation and solid waste management.

It has been observed that some of the State Public Health Engineering Department/Water Supply and Sewerage Boards and local bodies are not fully utilising the facilities provided under PHE Training Programme of the Ministry of Urban Development. It is, therefore, suggested that all such agencies must take full advantage of the same by deputing their officials in large numbers to various training courses sponsored by the Ministry of Urban Development.

RESEARCH AND DEVELOPMENT

Research and Development play a vital role in the overall development of water supply and sanitation sector. Realising the importance of R&D input in the sector, an outlay of Rs. 5 crores was provided in the VII plan under Central sector. It is envisaged to step-up R&D activities during the VIII plan period.

The Ministry of Urban Development, Government of India provides funds for applied research and development activities confined to the fields of urban water supply, sanitation and solid waste management sectors. Some of the important areas in which financial support is provided are, low cost and appropriate technology in water supply, sewerage and sanitation, systems approach to water supply and waste management, desali-

nation of water for drinking purpose, re-use and re-cycling of waste water, economical and appropriate technology of solid waste management, water quality surveillance, cost benefit analysis of various technology options, rapid and simple techniques for detection of faecal bacteria in field, studies of ways and means of resource generation from within the community, socio-economic aspects of water supply systems, water usage, recycling of wastes including solid wastes, studies on evaporation control in open water reservoirs, effective methods of low cost sanitation in rocky and difficult hydrogeological formations, advance techniques in treating water and waste water, energy recovery from wastes, artificial recharge of ground water, water and sewage tariff studies etc.

A list of research studies sponsored by the Ministry of Urban Development is at Annexure-III. Of the 16 studies so far sponsored, 5 have been completed and the rest are in progress.

It is envisaged to launch a pilot study on waste assessment, leak detection and preventive maintenance of selected water distribution systems in 6 Indian cities in collaboration with WAPCOS and NEERI. The said proposal is under active consideration of ODA (U. K.) for possible financial assistance. The study is likely to be launched some time in the later part of this year.

The various research organisations, educational institutions, field departments, local bodies dealing with urban water supply, sanitation and solid waste management activities are requested to take full advantage of the facilities being provided by the Ministry of Urban Development, Government of India and forward their R & D proposals for possible assistance. In addition, it is very necessary for the State Public Health Engineering Departments, Water Supply Boards and Municipal Corporations to have separate R & D cells in their organisations to carry out research work of applied nature in order to solve various field problems.

There is also an urgent need to develop proper MIS for R & D activities in the field of Water Supply, sanitation and solid waste management so as to make optimum use of such studies by various agencies. □

He who understands is learned
He who knows himself is wise
He who conquers others is powerful
He who subdues himself is strong
He who is contented is wealthy
He who does not lose his soul will endure.

Wherever I went, I saw people carefully careless and carelessly careful, honestly dishonest and dishonestly honest, criminally innocent and innocently criminal, regularly irregular, punctually unpunctual. Every one is mad after money, from Prime Minister to peon. The country may fall in permanent hell. In spite of all these the state is lingering on by the mercy of some hidden hand of Almighty.

—A foreign tourist

ANNEXURE I

LIST OF INSTITUTIONS RECOGNISED BY MINISTRY OF URBAN DEVELOPMENT FOR CONDUCTING ME COURSE IN PHE/ENVIRONMENTAL ENGINEERING.

Sl. No.	NAME OF INSTITUTION
1.	All India Institute of Hygiene and Public Health, Calcutta.
2.	V. J. T. I. , Bombay.
3.	Visvesvaraya Regional College of Engineering, Nagpur.
4.	Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar. (GUJARAT)
5.	Sri Jayachamarajendra College of Engineering, Mysore.
6.	Motilal Nehru Regional Engineering College, Allahabad.
7.	Shri G. S. Institute of Technology of Science, Indore.
8.	Anna University, Guindy, Madras.
9.	Malviya Regional Engineering College, Jaipur.
10.	I. I. T. , Bombay

ANNEXURE II

LIST OF REFRESHER COURSES SPONSORED BY THE MINISTRY OF URBAN DEVELOPMENT

Sl.No.	NAME OF THE COURSE
1.	Water Works Supervisors Course
2.	Sewage Works Supervisors Course
3.	Corrosion Control
4.	Water Supply System Management
5.	Water Treatment Plant Design
6.	Public Health Engineering Structures
7.	Waste Stablization Pond Practices
8.	Filter operation.
9.	Care & Use of Chlorinators
10.	New Developments in water Treatment.
11.	Pipes & conduits
12.	Water Analysts Course.
13.	Waste Water Analysts Course.
14.	Solid Waste Management
15.	Cathodic Protection
16.	Sewer Maintenance and Cleaning.
17.	Preventive maintenance & Leak Detection.
18.	Low Cost Sanitation - Water Seal latrines
19.	Pumping Equipment and their maintenance.
20.	Safety measures in PHE structures.
21.	Sewage Treatment Plant Design.

ANNEXURE III

R. & D PROJECTS SPONSORED BY THE MINISTRY OF URBAN DEVELOPMENT.

Sl. No.	Title	Name of the agency carrying out the work.	STATUS.
1	Performance Evaluation Study of Compost plants in 7 cities of Bombay, Delhi, Calcutta, Bangalore, Baroda, Jaipur and Kanpur	NEERI, NAGPUR.	Completed.
2	Performance Evaluation of Rural watersupply schemes in India.	NEERI, NAGPUR.	Completed.
3	Pilot Studies on De-salination of water for drinking purpose in 8 villages of 4 States.	CSMCRI, BARC, DRL.	Completed.
4	Performance Evaluation of. Water Treatment Plants in 51 towns in India.	NEERI, NAGPUR.	Completed.
5	Study of Solid waste Management in pilgrim towns.	NEERI, NAGPUR.	On going.
6	Research & Development of instruments in areas of water Management.	SJCE, MYSORE.	Completed.
7	Study of Urban Water Supply Tarrifs.	IIPA, Delhi.	On going.
8	Performance Evaluation of water Distribution System in 7 selected Cities of India.	NEERI, NAGPUR.	On going.
9	Development of Computer Software for sub system of Solidwaste Management in Indian context.	NEERI, NAGPUR.	On going.
10	Developing a method to extract water from sea coast fresh water aquifer.	IIT, MADRAS.	On going
11	Relative Evaluation of Lowcost methods of flocculation.	VRCE, NAGPUR.	On going.
12	Effectiveness of combined horizontal flow roughing filter and slow sand filter system.	Bengal Engg. College, Howrah.	On going.
13	Optimisation of Water Treatment system using dynamic Programming.	NEERI, NAGPUR.	On going.
14	Problems relating to drinking water in Urban slums.	Society of Development Studies, Delhi.	On going.
15	Fabrication of Leak detection Equipment (3sets)	SJCE, MYSORE.	On going.
16	Comparative Study of Treating Waste water using Waste Stabilisation Ponds.	TWAD BOARD, MADRAS.	On going.

Leakage Control Policy : Need and Relevance

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1. 0 INTRODUCTION

Conservation of water in the water supply systems is of vital significance in view of diminishing water resources in the country and should ensure reduction in water related diseases especially in the Indian context.

It is clearly uneconomic to ensure that pipelines and reservoirs will never leak. It is also clear that there is an economic limit to the loss of water that should be tolerated through leakage. Current leakage control practice within India, excepting Bombay, is primarily of repairing those leaks that become self evident thus expending minimum efforts. Leakage control in Indian cities has assumed another dimension of public health risk due to back syphonage of waste water into the water mains.

In the light of its economic and public health benefits, leakage control in India should be viewed as an integral and important facet of the water supply systems management.

2. 0 LEAKAGE CONTROL : INDIAN SCENARIO

The National Environmental Engineering Institute (NEERI) has, between 1971-1990 carried out pilot projects in major cities of India and arrived at water loss due to leakage ranging between 11–52 percent of the water supplied to the study districts (Table 1 and Figure 1) .Benefit-cost analysis also dictates that the conduct of waste detection on a routine basis could be an economically viable proposition (Table 2). The Major sources of the leaks in the distribution system have also been identified in these studies (Figure 2).

Some of the Indian cities have also initiated sample surveys on unaccounted for water in their water supply systems as a World Bank aided programme.

Realising the relevance in the present context, The Central Public Health and Environmental Engineering Organisation (CPHEEO), The Ministry of Urban Development, Govt. of India, has aptly emphasised the need for the formulation of National Policy on Leakage Control.

3. 0 LEAKAGE CONTROL POLICY

3. 1 APPROACH

The broad steps of the approach on Leak Detection Policy formulation are as follows:

Passive leakage control, regular sounding and waste metering are the three primary methods of leakage control practised in India. A detailed study on benefit - cost analysis of these methods is of relevance. In order to assess the waste levels or leakage levels using the above method, appropriate experimental programme should be designed. The cost data and accuracy attained in the field investigations would go a long way in achieving the desired objective. Figure 3 portrays an appropriate procedure for the determination of Leakage Control Policy.

3. 1. 1 LEAKAGES IN WATER DISTRIBUTION SYSTEM

Computation of waste level in the selected Waste Water Meter (WWM) District of a city water distribution network could be carried out by conducting the studies on water lossess in 10-15 repre-

sentative districts. Water quality analysis before and after control, health statistics, socio economic and sanitary surveys, if conducted, should strenghten the issue of policy formulation on Leakage Control.

3. 1. 2 TRUNK MAINS AND SERVICE RESERVOIRS

It has been the accepted fact that the leakage from most of the trunk mains and service reservoirs is relatively small. Nevertheless some trunk mains and reservoirs do have significant levels of leakage and so these parts of the system cannot be ignored during Leagage Control Policy formulation. The procedure for such leakage detection studies is available in the literature.

3. 1. 3 UNIT COST OF LEAKAGE

A fundamental component of the procedure in the derivation of the economic benefit to an undertaking is of changing leakage levels. This figure is relevant not only to all parts of the system but also has implications for subjects other than leakage control.

The benefit to the water supply undertaking is the effect, upon the expected costs of supplying water, of the change in demand brought about by a change in leakage. Past expenditure can in no way be affected by a future change in demand and is therefore,irrelevant. This change in costs which can be considered to be a saving brought about by a reduction in leakage, consists of two distinct elements :

- 0 A reduction in annual operating costs and
- 0 A deferment of demand related schemes effecting a reduction in the programmed capital investment.

The above approach incorporates total costs but, because each method of control will achieve a different leakage level within the same system, it is more convenient to express these cost reduction as a unit amount eg. Rupess per cu. m. (Rs/m3). This figure is referred to as the unit cost of leakage.

Unit Cost of Leakage = Unit Operating Cost + Unit Capital Cost ... A

$$\text{Unit Capital Cost} = \frac{(TDCCr^2)}{[(1+r)\ 3.65\ d]} \quad \ldots 1$$

Where : r is the discount rate; d is the annual change in demand (m3 /d) and TDCC is total discounted capital cost which is based on total modified capita cost of each capital works over a span of years.

It has been the experience of the water works engineers that the pumping costs is usually a dominent element.

Unit Operating (Pumping) Cost = (AM) B Q ... 2
Where : A is power input (KW); M is inflation multiplier; B is average unit charge (Rs) and Q is water supplied (m3 /hr).

POWER INPUT AND INFLATION MULTIPLIER

In some pumping stations the rate of energy consumption (power) in Kilowatts can be obtained directly from a power meter; however; if only voltage and current meters are available then power input is expressed as :

Power Input (A) = (1.73 × Volts × Amperages × power factor)/1000... (a)

In some undertakings pumping costs are calculated regularly. However, these are normally average costs. It has been found that these figures bear little relation to the pumping cost and consequently should not be used.

It has been observed over a period of years that electricity prices grow at a rate higher than the general rate of inflation and therefore, an inflation multiplier to A is recommended which is expressed as :

$$\text{Inflation Multiplier (M)} = \frac{\text{(Discount rate)}}{\text{(Discount rate—Differential Inflation rate)}} \quad \ldots 4$$

Unit Treatment Cost = E (Rs/m3) ... 5

E comprises of cost of chemicals used in water treatment, O & M of electrical and mechanical equipment, civil works, etc.

Substituting from equations 1 through 5 in expression A

$$\text{Unit Cost of Leakage (Rs/m}^3\text{)} = \frac{TDCC\ r^3}{[(1+r)\ 3.65\ d]} + (AM)\ BQ + E \quad \ldots B$$

3.1.4 FREQUENCY OF WASTE CONTROL ACTIVITIES

The frequency of regular sounding represents the rate at which each stop cock is sounded whereas average frequency of waste metering represents a capacity for inspection or the operational resources required. Figure 4 presents typical study carried out by NEERI which concludes that the frequency waste metering should be less that four years for the obvious reasons.

3.1.5 OPERATIONAL RESOURCES

It would be improper to decide that a single leakage control method for all cities and for all the districts in a city. Practical difficulties, financial resources and inconvenience to the consumers should be the principle parameters while deciding the leakage control methodology.

Once the appropriate method of leakage control has been chosen and the effort to be applied has been determined, it is possible to decide upon the operational resources required by this policy. Eventually starting levels can be estimated from the total level required using the frequency of such operations.

4.0 LEAKAGE CONTROL : CONSTRAINTS AND MISGIVINGS

- It is generally agreed that a comprehensive leak detective programme for water supplying system helps in reducting water lossess. Inspite of quantifyable and unquantifyable benefits, there has been no proper appreciation of this activity
- Expenditure incurred on the investigation is some times considered as a drain on financial resources and not the useful investment
- A lot of night work is involved especially while detecting leaks. There is no provision of any incentive to the dedicated staff who are helping in saving the expensive and diminishing resource
- Leakage control is an independent activity. It was observed that some of the trained engineers in this activity are assinged some other jobs
- Provision of adequate allocation for the purchase of material and equipments and unavailability of indigenous instruments are some of the bottlenecks

5.0 CONCLUSIONS

Formulation of Leakage Control Policy is of vital importance. The activities involved in this studies need better appreciation. NEERI's studies over two decades was possibly the first step in this direction. Indigenous manufacture of instruments is one of the important issue in the programme on Leakage Control.

A lot more needs to be done. It would be the water supply undertakings in this country who should take lead and implement the programme on Leakage Control effectively and interact with various organisations for the support, if necessary.

ACKNOWLEDGEMENTS

The authors are thankful to Prof. P. Khanna, Director, NEERI for the encouragement and also for the permission to submit the paper. Assistance rendered by the various water supply undertakings in conducting the field studies is greatfully acknowledged.

REFRENCES

1. NEERI Reports on Preventive Maintenance of Water Distribution system with reference to waste assessment, detection and control; (1971-1990).
2. Leakage Control Policy and practice by the Water Authorities Association, in conjunction with the Water Research Centre, London, U.K., (August 1985).

□

TABLE 1 WASTE FLOW COMPUTATIONS : INDIAN SCENARIO (1971-1990)

Name of the city	Population of each study Distt.	Number of connections	Normal supply hours	Average pressure (kg/cm2) at by-pass meters	No. of persons per conn.	Per connection waste flow (lit/hour)				percentage waste			
						Initial		After Control		Initial		After control	
						MNF	Stop cocks closed	MNF	Stop cocks closed	MNF	Stop cocks closed	MNF	Stop cocks closed
Nagpur	2500	393	24	1.45	6.4	26.3	24.5	6.2	—	47	44	11	—
Shimla	1240	198	3	2.2	6.3	172	—	10.3	—	49.7	—	—	3
	729	82	3	5.3	8.9	—	304	—	49	—	45	—	7.36
Ludhiana	1272	172	17	1.7	7.4	64.9	—	—	—	29.4	—	—	—
Srinagar	1692	181	24	0.6	9.3	15	—	3 9	—	24.7	—	6.4	—
Mysore	1640	180	21	1.8	9.1	42.4	—	8.6	—	26.2	—	5.37	—
Trivandrum	322	84	24	1.6	3.8	31	—	5.0	—	52.6	—	19.90	—
Coimbatore	1871	160	3	1.0	11.7	—	57	—	—	—	11	—	—
Cuttack	2740	248	10	0.2	11	—	33.33	—	—	—	21	—	—
Madras	2000	170	6	0.8	11.7	—	148	—	23.8	—	36	—	7
Lucknow	1517	149	24	0.4	10.0	—	10.5	—	3.8	—	19	—	6
Ahmedabad	1555	184	6	0.5	8.4	—	54.3	—	3	—	20	—	1.1
	1703	150	5.5	0.56	11.3	—	57	—	5.4	—	25.5	—	2.4
Surat	2580	318	7	0.9	8.0	—	60	—	8.6	—	26	—	3.7
	3747	311	5.5	1.26	12.0	—	103	—	4.7	—	24	—	1.1
	2625	301	5.5	1.5	8.7	—	53.8	—	3.9	—	25	—	1.8
Cochin	3639	302	15	0.9	12.0	—	19.4	—	2.6	—	21	—	3
	2207	296	15	1	7.5	—	23.5	—	4	—	41	—	8
Jaipur	1440	179	8	1.7	8	—	56	—	7.4	—	26.5	—	3.5
	4198	344	7.5	2.1	12.2	—	33.5	—	3.5	—	25	—	2.6

TABLE 2. BENEFIT – COST ANALYSIS OF WASTE ASSESSMENT AND CONTROL (1971-86)

(Based on Pilot Studies)

S. No.	City	Population in study area	Labour cost in Rs	Material cost in Rs.	Super-vision cost in Rs	Total cost in Rs	Investment Pay Back Period based on water saved in months	Total Period of Project	
								Preparatory work months	Work Period in months
1.	Bombay	8,000	*	*	*	11,000	5.5	4	1.5
2.	Madras	2,620	5,485	14,615	20,050	40,150	15.0	3	1.5
3.	Aurangabad	6,180	1,169	5,330	2,495	9,094	18 to 20	3	1.5
4.	Ahmedabad	3,260	9,330	18,200	2,000	19,530	18 to 24	4	1.5
5.	Surat	8,950	11,000	71,540	4,000	86,540	18.0	6	4

* Details not available

Waste due to leakages-*Indian scenario*

BASED ON PILOT STUDIES IN WATER DISTRIBUTION SYSTEM

(1971 - 1990)

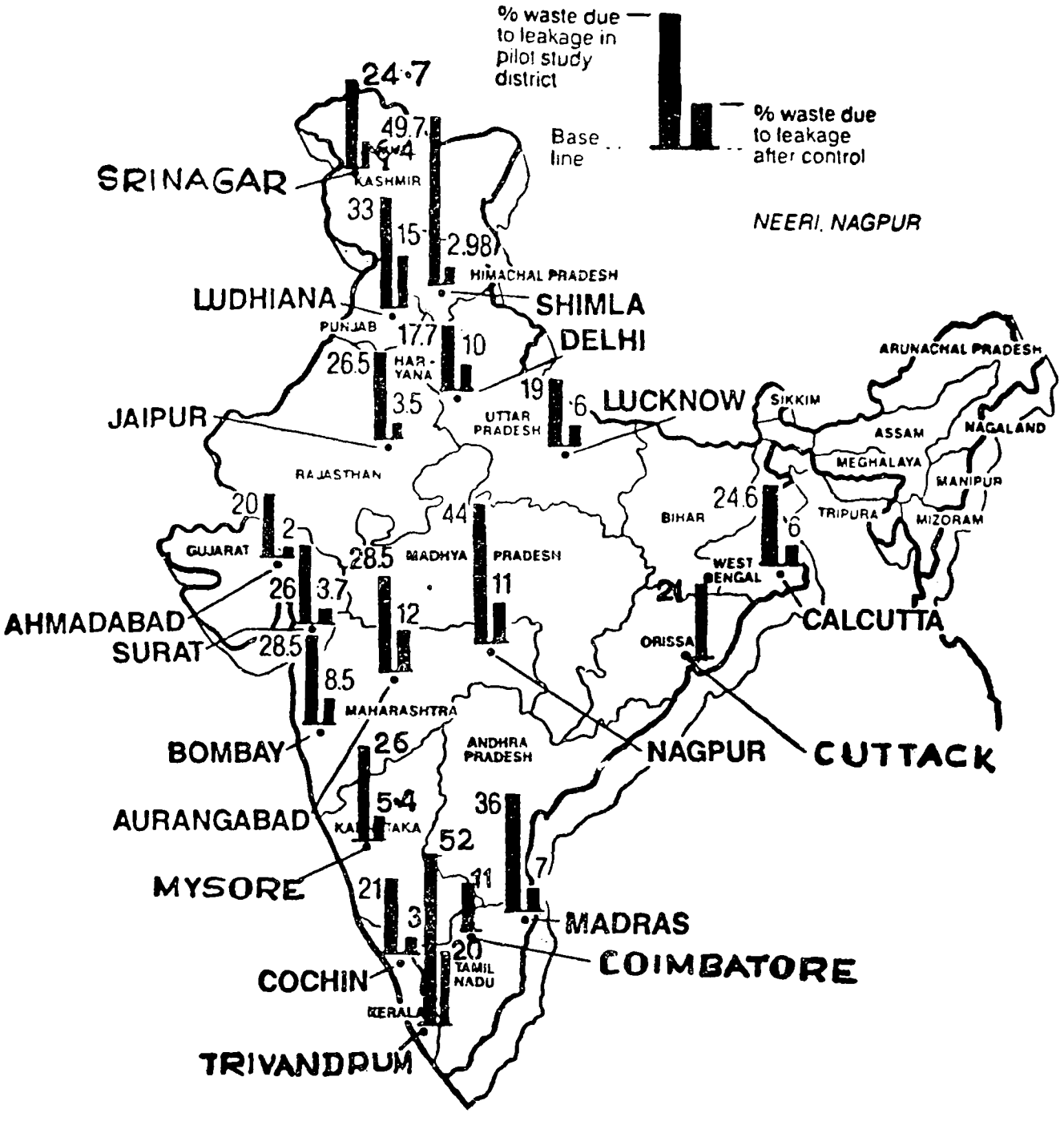


FIG. 1

Type of leaks – *percentage distribution*

Detected in pilot study districts of various cities in India

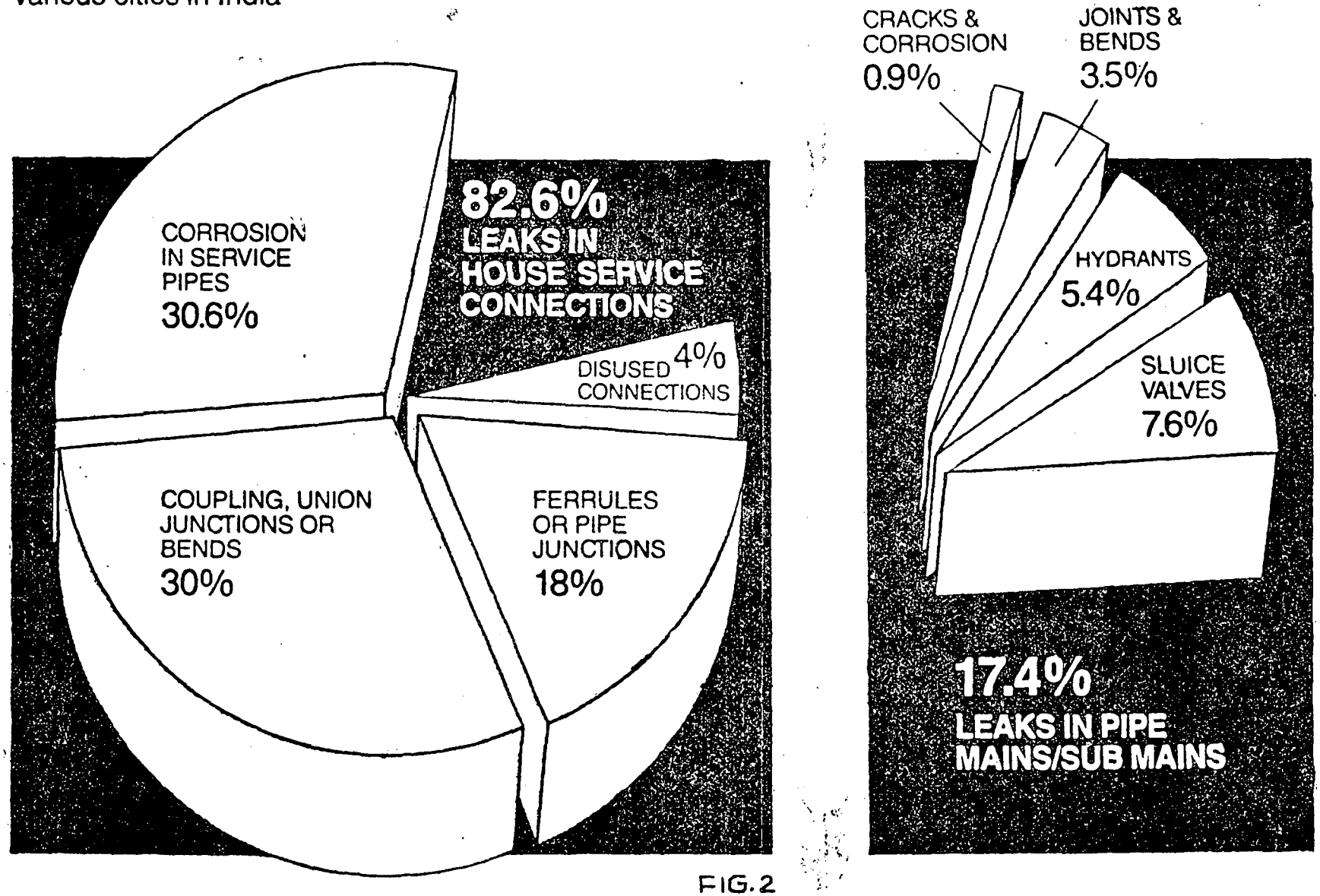


FIG. 2

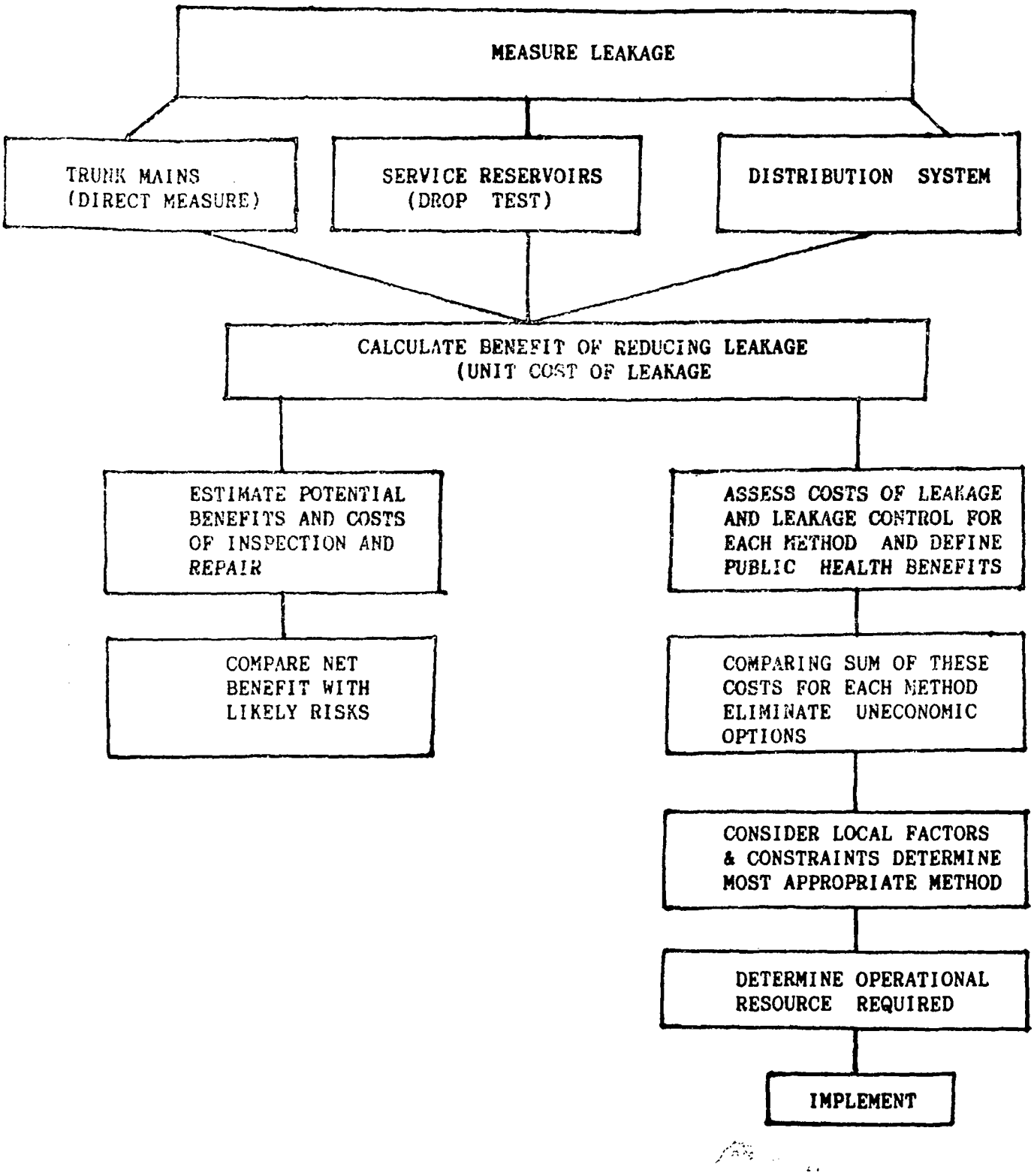
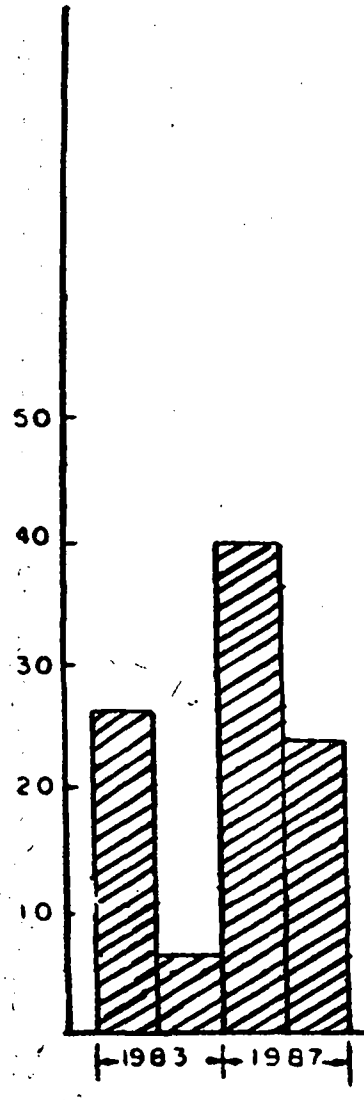


Fig. 3. Flow diagram of the procedure for the determination of leakage control policy

WWMD : SHANKAR NAGAR (WEST), NAGPUR



DETAILS OF WASTE WATER METER DISTRICT		
DESCRIPTION	YEAR	
	1983	1987
TOTAL POPULATION	2500	—
TOTAL HOUSE SERVICE CONNECTIONS	393	-
DAILY WATER SUPPLY IN TO THE DISTRICT (Litres)	5,04,583	6,44,300
AVERAGE SUPPLY PRESSURE (Kg/cm^2)	1·45	—
WASTE FLOW BEFORE LEAK REPAIRS (l/m)		
AT 2·80 Kg/cm^2 (Obsrved)	—	260 (58%)
AT 1·35 Kg/cm^2 (Observed)	173 (49%)	160 (39%)
Expressed as lit / connection / hr AT 1·35 Kg/cm^2	26	24
WASTE FLOW AFTER LEAK REPAIRS (l/m)	41 (11%)	-
Expressed as lit /connection /hr.	6	

CONCLUSION: Initial waste level (1983) was 26 l/conn/hr. which was brought down to (after leak repairs) 6 l/conn/hr. After about 4 years (1987), waste level is 24 l/conn/hr. Therefore the frequency of waste Metering should be less than 4 years

FIG 4 FREQUENCY OF WASTE METERING

Economic Analysis of Water Distribution System: A Case Study of Air- Force Naval Housing Board, Bangalore

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NOTATIONS USED

1. B_A : Bore well in zone A
2. B_B : Bore well in zone B
3. B_E : Bore well in zone E
4. E_T : Existing tank of 4, 00, 000 ltr. capacity
5. P_T : Proposed tank of 3,00,000 ltr. capacity.
6. GPH: Gallons per hour
7. D : Diameter of pipe

1 INTRODUCTION

Economic analysis of any water distribution system will help in reducing initial cost and operation, maintenance and replacement costs of the project. Economic analysis is carried out for selecting the best project among different alternatives available.

In this study an attempt has been made to find out the best water supply scheme for Air-Force Naval Housing Board layout in Bangalore city. It has been tried to find out the minimum cost involved in transporting water from the four sources available in the area to each of the two over head tanks. The standard transportation model is applied to obtain the optimal solution.

2 DETAILS OF STUDY AREA

Air-force Naval Housing Board layout is a new layout formed in the area known as Banasavadi in the eastern part of Bangalore city. The area of the layout is about 8.22 hectares. There are 548 houses belonging to different types as given below :

Type - i : Two bed room house with study room servant room and garage

Type - ii : Two bed room house with study room and garage

Type - iii : Two bed room house

Type - iv : Single bed room house

Complete details of these houses are as given in Appendix - 1

3 WATER SUPPLY DETAILS OF THE STUDY AREA

There are three borewells in the study area. The location of these wells is shown in the layout plan (fig-1). The yield and other details are given in the table 1. There is one overhead tank as indicated in fig-1 and it is proposed to construct one more overhead tank. In addition to these borewells, Bangalore water Supply and Sewerage Board (BWSSB) will be supplying 5, 00, 000 lts/day at the point 'X'

as shown in the layout plan. Hence these borewells and the supply from BWSSB have been considered as sources and two overhead tanks as destinations in the transportation model.

Table-1 : Details of Borewells in the Study Area

Bore well in zone	Depth	Yield	Maximum Yield per day
A	400 ft.	2500 GPH	20, 000 gallons
B	410 ft.	1000 GPH.	8, 000 gallons
C	460 ft.	3000 GPH	24, 000 gallons

The cost of the water supplied by BWSSB as per the prevailing rates is as given in Table 2.

Table - 2 : Cost of Water Supplied by BWSSB

Consumption Lts/month	Rate in Rs. per 1000 Lts
0-10,000	0.35
10,000-25,000	0.45
25,000-50,000	0.65
50,000–1,00,000	0.75
> 1,00,000	1.25

4 DAILY WATER DEMAND

By using the standard method, the population of the area has been projected for 2000 AD and it is estimated as 4730 as against the present population of 2740. The demand of water is estimated for different purposes as follows:

1. Domestic use
2. Industrial use
3. Fire fighting
4. Miscellaneous

Taking consumption for domestic use as 140 Lt/day/capita, the domestic use demand works out to be 6,62,200 Lts/day. Since there are no industries in the layout, industrial demand can be neglected. By making suitable allowance for miscellaneous uses, the total demand can be taken as 7,00,000 Lts/day.

5 COST ANALYSIS

For transportation model, the cost involved in supplying a unit quantity of water from each source to different destinations are to be worked out. The cost details are as given below:

1. Construction cost of overhead tanks
2. Construction of low level sump
3. Cost of water supplied by BWSSB
4. Cost of pipe line from source to destination
5. Cost of drilling borewells
6. Cost of installation of pumps for
   a. each borewell
   b. sump to overhead tanks
7. Pumping cost
8. Operation and maintenance costs

Knowing the period of analysis of each component, rate of interest and different costs involved, the annual worth has been calculated. For calculation purposes, one unit of water is taken as equal to 1000 Lts., the costs of which have been taken from the schedule of rates and prevailing market rates at Bangalore. Suitable life periods have been assumed for different components of the project.

Since BWSSB is supplying in different slab rates, the cost has been considered accordingly as W1, W2, W3, W4, and W5. The unit cost matrix is as given below,

Table - 3 : Unit Cost Matrix

	E_T	P_T
B_A	1.735	1.859
B_B	2.349	2.382
B_E	1.623	1.745
W_1	1.211	1.218
W_2	1.311	1.318
W_3	1.511	1.518
W_4	1.611	1.618
W_5	2.111	2.118

6 TRANSPORTATION MODEL

A transportation model has been formulated with the following constraints,

1. Demand constraint :

It is required to store 7, 00, 000 lts of water in both the tanks. Hence the capacity should not be less than 7,00,000 lts.

2. Supply constraint :

This is not a equality constraint since it is required to draw maximum quantity of water available.

With these constraints, the transportation model will be as follows :

Table - 4 : Transportation Model

	E_T	P_T	S . C
B_A	1. 735	1. 859	90. 93
B_B	2. 349	2. 382	36. 37
B_E	1. 623	1. 745	109. 11
W_1	1. 211	1. 218	0. 333
W_2	1. 311	1. 318	0. 5
W_3	1. 511	1. 518	0. 833
W_4	1. 611	1. 618	1. 667
W_5	2. 111	2. 118	496. 667
C.D.	400	300	

Here, S. C = Supply Constraint

D. C = Demand Constraint

7 ANALYSIS AND RESULTS

For solving the transportation model, Vogel's approximation method has been used. A dummy sink has been added to balance the transportation model. The optimised allocation obtained by solving the model is as given below :

Table - 5 : Optimal Allocation

	ET	PT	D
B_A	90.930(1.735)	—	—
B_B	—	—	36.37(0)
B_E	109.110(1.623)	—	—
W_1	0.333(1.211)	—	—
W_2	0.500(1.311)	—	—
W_3	0.833(1.511)	—	—
W_4	1.667(1.611)	—	—
W_5	196.627(2.111)	300(2.118)	0.04(0)

8 MODEL VERIFICATION

Results obtained from transportation model can be checked by using linear programming method. For this purpose a computer program in FORTRAN language has been used. The objective function of the model is to minimise the cost of transportation of water.

The objective function is,

$$\text{Min } Z = 1.735\,X1 + 2.349\,x2 + 1.623\,X3 + 1.211\,X4 + 1.311\,x5 + 1.511\,X6 + 1.611\,X7 + 2.111X8 + 1.859X9 + 2.382X10 + 1.745\,X11 + 1.218\,X12 + 1.318X13 + 1.518\,X14 + 1.618\,X15 + 2.118\,X16$$

Subjected to :

Supply Constraints

$$X1 + X9 \leq 90.93$$
$$X2 + X10 \leq 36.37$$
$$X3 + X11 \leq 109.11$$
$$X4 + X12 \leq 0.333$$
$$X5 + X13 \leq 0.5$$
$$X8 + X14 \leq 0.833$$
$$X7 + X15 \leq 1.667$$
$$X8 + X16 \leq 496.667$$

Demand Constraints

$$X1 + X2 + X3 + X4 + X5 + X6 + X7 + x8 = 400$$
$$X9 + X10 + X11 + X12 + X13 + X14 + X15 + X16 = 300$$

and $xj > 0$ for $j = 1, 2, \ldots\ldots16$ Non negativity constraints where X1, X2.....X16 are decision variables.

The data are fed to computer and results obtained are same as the results obtained from transportation model. The results are :

The minimised cost of transfering water is

$z = 1.735X90.93 + 0X36.37 + 1.623X109.11 + 1.211X0.33 + 1.311X0.5 + 1.511X0.833 + 1.611X1.667 + 2.111X196.627 + 2.118X300 + 0x0.04$

= Rs. 1390.33. Hence cost per 1000 litres

= Rs. 1.986 and from the alocation table, water should be drawn as given below,

i. From bore well in zone A (B_A) – 90,930 litres/day.
ii. From bore well in zone B (B_B) – no water should be drawn
iii. From bore well in zone E (B_E) – 1,09,110 litres/day
iv. From B. W. S. S. B – 1,99,960 litres/day to Existing tank (E_T)
v From B. W. S. S. B. 3,00,000 litres/day to Proposed tank (P_T)

9 CONCLUSIONS

Analysis indicates that no water should be drawn from the bore well in zone B (B_B). That is, bore well B_B is not at all necessary. Hence, before implementing the project, one can check it's economy and select the best alternative. At present, the borewell B_B can yield about 1000 gallons per hour at depth of 410 feet. As such, it is better to supply water from B. W. S. S. B. (even with higher slab rate) than using borewell B_B. It is seen that having borewells zone A and zone E is economical.

10 SCOPE FOR FURTHER STUDY

Similar methodology can be adopted for any city and an economical Water Distribution System can be evolved.

11 REFERENCES

1. B. W. S. S. B. Report on "Water Supply and Sewage Disposal for Bangalore" Vol.1, Water Supply, Binnie and Partners (India) Ltd. Chartered Civil Engineers, London, March 1966.
2. V. S. Chauhan and P. Khanna. "Computerization of Water Distribution Network Analysis", Journal of Institution of Engineers (India) Vol. 52, No. 6, february 1972, pp.41.
3. Robert B. Robinson and Tom A. Austin, "Cost Optimization of Rural water Distribution Systems", Journal of the Hydraulics Division, A.S. C. E., Vol. 102, No., HY8, August 1976,pp. 1119.
4. Keith W. Little and Brian J. MC Croddent "Minimization of Raw Water Pumping Costs using MILP", Journal of Water Resources Planning and Management, A. S. C. E., Vol.115 No. 4, July 1939, pp. 511
5. Kevin E. Lansey and Larry W. Mays, "Optimization Model for Water Distribution System Design", Journal of Hydraulics Engineering, A. S. C. E., Vol. 115, No. 10, October 1989. pp. 1401.
6. Don T. Phillips, Ravindran A. and James Solberg, "Operations Research Principles and Practice", John Wiley & Sons, New York, 1976.
7. Sharma S. D. "Operation Research", 8th Ed. Kedarnath and Ramnath & Cpo. Meerut, 1990.

□

CLOUD SEEDING

The artificial rain-making or cloud-seeding is reported to have been done at a few selected places around the globe with a measure of success. To the question whether it rained because the cloud was impregnated with silver-iodide or was it normal, unaided natural shower, there is no positive answer.

Though operations in cloud-seeding are being reported since late forties hardly any advance has been made in cloud modificiation technology or methodology. Cloud physics continues to be very difficult and challenging scientific problem. If the clouds are sufficiently deep, cummulous (water bearing), vigorous and long lived, seeding may induce showers from light to heavy depending upon the nature of cloud, weather conditions and technology adopted. The question which remains unsolved is whether the experiment would give economically encouraging results with assured degree of accuracy over the pre-selected target area. Also one is at difficulty to explain whether the rainfall. thus reported was due to natural effects or artificial seeding.

It was in 1946 that silver iodide was first identified as a cloud - seeding agent and has been in use since then. Spraying powdered dry ice is another method which was tried in earlier experiments with limited success.

For a large country like ours, failure of monsoon is likely to occur in one part of the nation or other almost every year. It is felt that it is time India has its own cloud - seeding agency whether owned by Government or private to undertake missions at short notice and less cost.

APPENDIX - I

DETAILS OF HOUSES

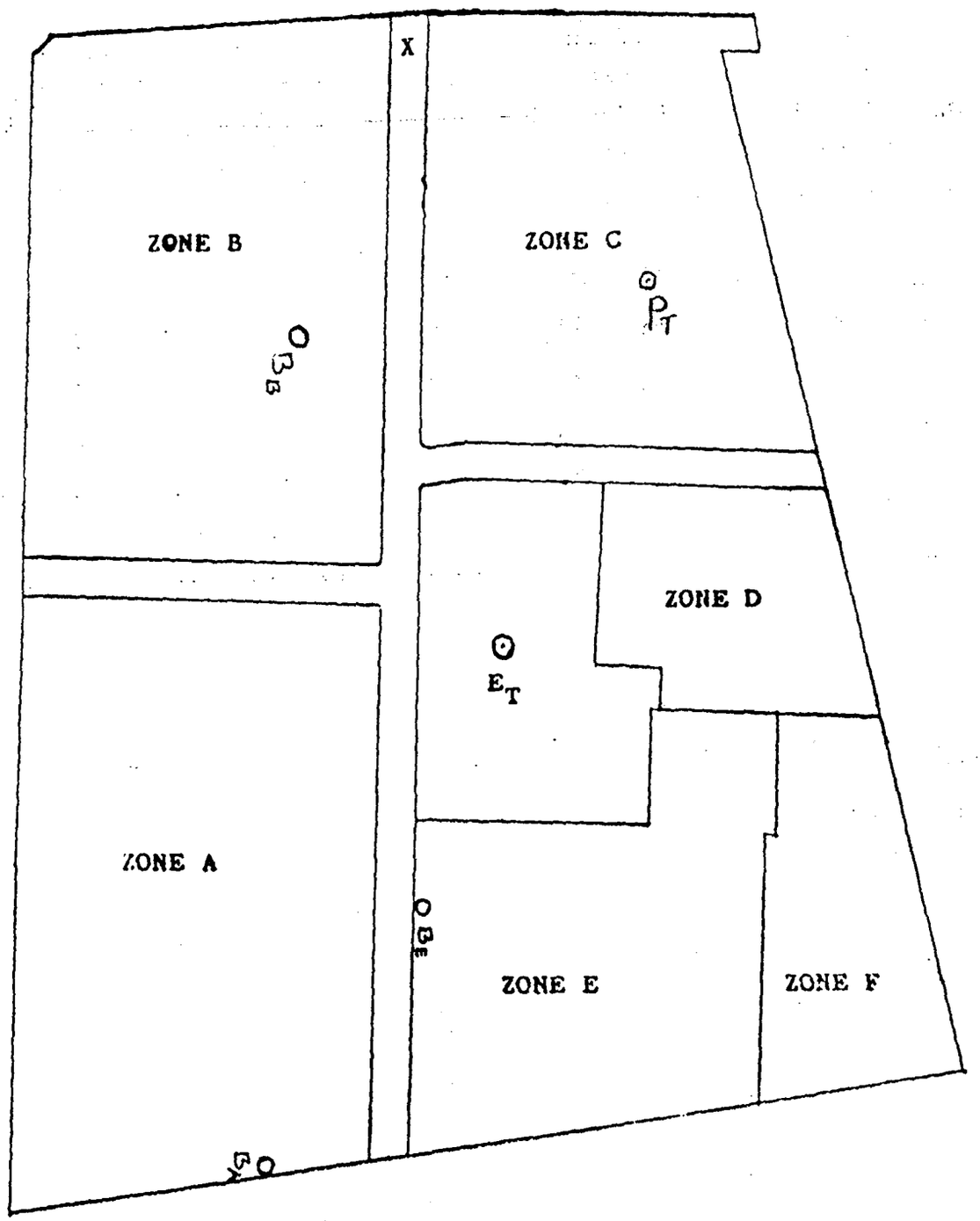
SECTOR	TYPE I			TYPE II			TYPE III			TYPE IV		
	G.F.	F.F.	S.F.	G.F.	F.F.	S. F.	G.F.	F.F.	S.F.	G. F.	F. F	S. F.
A	11	11	—	34	34	17	—	—	—	10	10	5
B	12	12	—	30	30	15	—	—	—	8	8	5
C	7	7	—	20	20	10	—	—	—	7	7	3
D	—	—	—	14	14	7	—	—	—	2	2	1
E	2	2	—	20	20	10	—	—	—	8	8	4
F	—	—	—	—	—	—	34	34	34	—	—	—
TOTAL	32	32	—	118	118	59	34	34	34	35	35	17

G. F. : Ground Floor

F. F. : First Floor

S. F. : Second Floor

FIG. 1 PLAN OF THE LAYOUT AFNIIB



(not to the scale)

Suitability of the Method of Charging cost of Water Supplied to the Public

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ABSTRACT

At present there are two methods of charging cost of water. One is metered supply method and other is Flat rate method. The suitability of a particular method depends on the system of water supply. In the case of continuous supply system, metered method of charging cost is found to be good. If the system of supply is intermittent, Flat rate method of charging cost may be adopted. The accuracy of measuring flow through water meter decreases with time, therefore meters should be examined regularly and replaced if the error in the measurement is found to be more than $\pm$ 10%. Flat rate should be decided on the basis of probable consumption of water. In this paper suitability of the method of charging cost of water is discussed.

INTRODUCTION

Water is the second essential requirement of life. No life can exist without water. In a public water supply system, the cost of water is charged from the consumer, according to the quantity of water consumed by him. The method of charging cost of water should be simple and easy. The consumer of water should pay its cost without hesitation. The usual common methods of charging cost of water has been discussed with regard to their suitability.

METERED SUPPLY METHOD

In this method a water meter is installed at every house connection. The flow of water is recorded by the meter and reading of the meter is taken by a meter reader before and after the end of the month to find out the consumption of water and water bills are prepared according to the quantity of water consumed. If meters work properly and readings are taken and recorded honestly, this method is a very good method of charging cost of water, when water is supplied continuously for 24 hours. Meters should be maintained properly. They must be examined and tested regularly at an interval of every six months for their accuracy of measurement. If the error is found to be more than $\pm$ 10%, the meter should be replaced with a new one.

It has been observed that many times meters are damaged, the readings are manipulated or changed and recorded incorrectly. In such a situation meter becomes an obstruction to the normal flow of water, because the purpose for which it is installed is not served. Meter causes loss of head and add to cost of pumping.

There should be rules of heavy punishment to persons who tamper with the water meter or meter readings including the disconnection of water supply. These rules must be strictly enforced.

FLAT RATE METHOD

In this method Meters are not provided and a fixed amount of money is charged from the consumer on the basis of probable consumption of water. Since meters are not provided, there is no need of meter reader and the head loss caused by meter is also eliminated, this will tend to increase residual pressure at the consumers tap. This method of charging cost of water is suitable, when the system of supply is intermittent. In intermittent system of supply, water is supplied for few hours of the day.

The pipe lines are filled with air for most of the time. When water is supplied to the consumers, the air present in the pipe line will be forced to come out through the water tap under pressure and can move the needle of water meter, if meters are provided. Thus the flow of air through water meter is recorded as flow of water, which is not desirable.

When meters are not provided there is no possibility of recording flow of air as flow of water. All the difficulties of water meters are removed. There are no chances of damaging the meter, alteration of water meter readings. The problem of repairing, testing and replacing the meter is also avoided.

The amount of money charged per month in this system should be revised from time to time depending on the consumption of probable amount of water.

As water is supplied to the public from a service Reservoir, there is uniform decline in the hydraulic gradient line for the water supply pipe. The hydraulic gradient line should be drawn on a paper for every pipe line of the area. The size of pipe and the value of discharge flowing should be written for every pipe line. Such charts should be prepared by theoretical calculations using well-known flow formulae. These values of pressure and discharge must be verified by taking field observations at the time of supply of water. Once such calculations are made and verified in the field, it becomes very easy to find the most probable consumption of water of any consumer. The value of discharge, multiplied by the time of supply can give the probable quantity of water consumed.

CONCLUSION

The metered supply method is suitable for continuous supply system. The meters must be maintained in good condition in order to obtain proper revenue of consumption of water. The flat rate method is suitable for intermittent water supply system. It avoids the use of meters but the flat rate should be fixed on the basis of probable consumption of water. To determine the probable consumption of water, calculations of discharge and its physical verification at the site must be made from time to time in order to obtain proper revenue by this method. □

Revenue For Water Supply: Water Tariff And Few Other Aspects

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A few years ago, it was thought that water should be free for some categories of users. This idea was supported by politicians in the name of equity. It was explained that the right to water had been recognised in the religions and cultures. This view is no more prevalent now. The principle of applying a general charge was initially accepted in urban areas and gradually extended to rural areas; the problem is no longer whether to charge, but of deciding to what extent the cost of the service should be covered by receipts.

One solution to the problem is to make complete recovery at the state level by charges levied. But in the context of a 'health for all' policy, assessment criteria based on the principle of recovering the total cost may lead to the rejection or showing down of most of the projects, those designed to provide for the least previleged. Further, the financial stability of the authorities concerned is also considered a pre-requisite for the equitable distribution of services, an argument deriving from the failure of many attempts to extend services and from the lack of financial autonomy in existing ones. Continuous government subsidies for maintaining the water supply schemes cannot be a healthy practice.

CONSIDERATIONS FOR FIXING TARIFF:

Many people will be unable to pay the full cost of water needed by them. It is, therefore, necessary to have differential scales of charges so as to serve the least previleged, at prices corresponding to their means and to recoup this subsidy by applying higher rates to other consumers. Consumers, whose demand exceeds production capacity, can be charged in relation to the future cost of installations as well.

But low income groups, whose consumption is small, should only have to pay to meet costs for which they are directly responsible and only if these costs correspond to real expenditure.

The need for water authorities to have financial autonomy makes it essential that average charges should cover average costs. It is not necessary for everyone to pay the same tariff, nor tariffs cover future costs of expansion. On the other hand, the revenue must cover all the expenditure, including that on repairs.

The general aim of the water sector should be to derive the greatest possible benefit from the available resources. This requires tariffs high enough to discourage excessive consumption that would require costly increases in capacity.

OBSERVATIONS AND RECOMMENDATIONS MADE IN THE NATIONAL SEMINAR ON WATER TARIFF IN SEPTEMBER '86:

A National Seminar on water and sewerage tariff was held in Srinagar from 9th to 11th September, 1986. A serious concern was raised over the inability of most of the water agencies to recover atleast the operation and maintenance cost and the consequent burden on the exchequer resulting in draining of plan resources earmarked for development. Since enormous capital investment is needed to achieve the goals of providing water supply and sanitation facilities through a large number of systems which would again require a large amount of finance to maintain, adequate tariffing was considered to be very important issue for the successful coverage and continued support to the commu-

nity. The various problems facing the water supply sector were considered and the following observations and recommendations were made.

1. In most of the water supply schemes, the existing tariff structure is not capable of realising adequate revenue potential due to the weak revenue collection machinery–Immediate action is needed to gear up the same.

2. The present arrangement for compilation of information on production and distribution costs of the services are inadequate to effect cost control and future planning- Reforms are needed to fill the gaps.

3. The financial analysis of tariff structure is not undertaken regularly, resulting in considerable time lag for tariff revision - Improved guidelines are necessary to reduce the time lag.

4. Metering of water supply systems is necessary for domestic, non-domestic as well as for bulk supply and area wise supply for effective monitoring of cost.

5. The tariff policy should be based on socio-economic considerations and affordability. Basic minimum per month consumption should be fixed for domestic unit, with reasonable tariff. Consumers using more than this should be charged progressively higher. Also cross subsidisation of water and sewerage tariffs should be introduced.

6. Reasonable autonomy should be given to local authorities by decentralising the water supply and sanitation system operating as a separate cost centre. Water supply agencies should have power to index tariff in proportion to cost variation of major items of expenditure, such as electricity, without the Government approval.

7. Whereever feasible, public standposts should be minimised, group standposts for weaker sections should be encouraged to ensure revenue from beneficiaries or municipality or Government.

8. The meter reading and billing procedures be optimised.

9. Public awareness and active participation be mobilised.

10. Commercial Accounting system should be encouraged as it helps in financial analysis and performance evaluation and tariff restructure.

It is clear that the need for proper tariff policy and the necessity to realise the costs through a proper tariff structure considering the principles of adequacy, fairness, simplicity and enforceability are well understood. But how far we could go into solving the issues is to be assessed. The cost of operating the water supply schemes is increasing steeply and the gap between the cost and revenue is widening. The position in Kerala Water Authority is given below:

(Rs. in Lakhs)

Year	Cost of Operation & Maintenance (excluding depreciation)	Revenue collected	% of Revenue to Cost
1986-87	962.40	629.59	65.4
1987-88	1355.87	853.97	63.0
1988-89	1372.59	915.19	66.8
1989-90	1759.40	1044.85	59.4

The cost of operation & maintenance and the revenue receipts in a few urban areas in India is given in Appendix-1. Except Bombay, Kanpur and Meerut, all the other places are showing a net deficit. It will be a useful exercise to study the systems and practices followed in Bombay with a view to implement the same in other cities with necessary changes.

AN INTEGRATED APPROACH FOR TARIFF POLICY:

However, in general, with the present rate of increasing costs, it will not be possible to match the costs with any amount of tariff revisions alone. A tariff policy with an intergrated approach with due considerations for cost reductions, indirect tariffing, improving the administrative set up and creating a public awareness will be necessary for bridging the gap of cost and revenue.

1. COST OF REDUCTION:

Some of the ways by which costs can be reduced are

— use of appropriate technology
— carrying out of preventive maintenance
— detection and reduction of losses and wastages

— control of illegal connections

— handing over to the private sector, areas that cannot be carried out economically by a public service.

2. INDIRECT TARIFFING: New areas for raising additional revenue through indirect means are

— a charge on water supply installations like water taps, shower taps, wash basins, bath tubs etc., based on the number of installations

— a charge on water storage tanks, overhead tanks etc., based on storage capacity

— a charge on equipments like washing machines, dish washers, water heaters etc

— a fee for putting up borewells.

3. IMPROVING ADMINISTRATIVE SET UP: Certain measures which can improve the revenue collections are

— create a proper organisation structure

— develop a perfect accounting and auditing system

— ensure prompt and regular monthly billing

— set up targets and offer incentives

— improve facilities for monthly remittance of water charges.

— computerise the billing and revenue accounting.

4. CREATING PUBLIC AWARENESS: The consumer should be made aware of the following facts by wide publicity

— as to what is the cost of treatment and distribution of water

— that the water tariff is meant for meeting the cost of bringing potable water at the doorstep of the consumer

— that they will have to incur much more to get water through other sources

— as to the steps they should take to prevent loss and misuse of water.

What is more water pricing should not be considered as the prerogative of water authorities alone. The water authorities should seek the active involvement of revenue, health, development, planning etc. departments in fixing up tariff and mobilising resources. The indirect benefits derived by the society should be discounted from the cost and supplemented by the other benefitted bodies.

CONCLUSIONS :

1. The implementation of the observations and recommendations made at the National Seminar on Water & Sewerage tariff held at Srinagar in September 1986 should be assessed.

2. Efforts should be continuously made to reduce costs in order to minimise the burden on the consumers.

3. Administrative machinery be toned up to get the maximum revenue in the existing tariff structure.

4. The consumers should be made aware of their role in helping the water authorities and also the reasons for tariff revision.

5. All the other connected departments and organisations should be actively involved in the activities of the Water Authorities.

REFERENCES :

1. Water for all - who pay? World Health Forum Vol. 8-1987

2. Proceedings of National Seminar on Water and Sewerage Tariff - September 1986.

(Cont.)

APPENDIX-1

Water Supply-Performance Indicators

Town	Revenue Collected from Water Supply			Expenditure			Net Revenue with	
	Tax	Rate	Total	O&M	Debt	Total	O&M Only	O&M + Debt
Ahmedabad	284.40		284.40	679.20	193.63	872.83	-394.80	-588.43
Bangalore	0.00	1981.69	1981.69	1820.09	401.90	2221.99	161.60	-240.30
Baroda	100.59		100.59	286.13	113.79	399.92	-185.54	-299.33
Bhopal		34.65	34.65	127.40		127.40	- 92.75	- 92.75
Bhuj	13.37		13.37	16.40		16.40	- 3.03	- 3.03
Bombay	5891.00	1280.00	7171.00	4132.00	281.00	4413.00	3039.00	2758.00
Coimbatore	118.85	58.04	176.89	45.45	300.25	345.70	131.44	-168.81
Gulbarga		5.48	5.48	41.72		41.72	- 36.24	- 36.24
Hubli		39.78	39.78	51.15	22.10	73.25	- 11.37	- 33.47
Kanpur	225.91	151.89	377.80	365.88		365.88	11.92	11.92
Lucknow	94.60	92.93	187.53	200.17		200.17	- 12.64	- 12.64
Madras	169.32	585.76	755.08	655.20	193.63	848.83	99.88	- 93.75
Madurai	52.48	72.07	124.55	74.91	86.21	161.12	49.64	36.57
Meerut	4.55	33.05	37.60	35.24		35.24	2.36	2.36
Mysore	8.34	38.68	47.02	65.50	20.34	85.84	- 18.48	- 38.82
Salem	20.39	38.63	59.02	69.83	33.45	103.28	- 10.81	- 44.26
Surat	31.57	92.48	124.05	208.86		208.86	- 84.81	- 84.81

Source : Study on Delivery and Financing of Urban Services by Operations Research Group, Baroda, India.

DRINKING WATER SECTOR DEVELOPMENT

The Appropriate Approaches to Impact Areas to Strengthen the Development of the Drinking water Sector in India

(Short Reflections of a leaving Expatriate)
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The drinking water sector, as perceived by me here during my stay in Kerala, India, is a (semi) governmental sector, where the contact between the producer of the public commodity (drinking water and sanitation) with their clients (consumer, public) is only minimal and often indirect. The State, as the intermediary is often used as the scapegoat for their differences and problems.

This implies that the inherent weaknesses of the inclusion of the public administrative system also influences the working of this sector and therefore shows:

A an over-administrative and bureaucratic attitude.

B the influence of the public political system in the working of the public enterprise, resulting in:

* interventions in the personnel management of the Drinking water Body,
* decisive influence in the water price fixation, more from the political than the economical angle,
* certain further influences in the general management of the Water Body.

The Drinkingwater sector thus projected against some of the healthy and sound influences of a direct open market-prices system, has the tendency to become an inefficient, slow, sluggish institute of bureaucrats often resulting in a parasitical situation on the public resources.

To cure this situation it is advocated to study the possibilities to arrive at a sound and healthy mixture of the positive efforts in the public sector with those in the private enterprise systems.

The underlying conditions of water supply to the society is to provide against remuneration, in a socio-economically acceptable way, its people and their activities of an adequate amount of potable water to satisfy their needs.

This thus is a sociological-as well as an economical issue. For the USERS the question is: how can I have in the most appropriate way the least costly water, of the right quality, for my needs? For the PRODUCER the question is how to provide the water to the clients in the right quantity and quality without incurring losses.

What are the motives behind the needs of the PEOPLE for water: direct consumption, indirect for cooking, cleaning, irrigation, industry, cooling, gardening, aesthetic use etc. For all these needs the same quality of water is not needed. How much is, or will, the consumer be prepared to give/pay for water received for his needs?

What is the motive for the producer to provide this commodity: "Water". In first instance, like most of the producers who provide goods to fullfill the needs of the society: the remuneration for his work and investment, mostly on a profitable base. Now what is the problem if consumer and producer come to a mutually accepted agreement. If there are no major obstructions and obligations to this approach, where and when does the government then come into picture? It is mainly in the scope of control, health and (with piped water supply) the important infrastructural repercussions, planning, the prevention of (private) monopolisation and the overall economical planning of inter-regional development policies; where the government may have to intervene. The slogan used by some orators; that water should not be taxed as it is a free, god-given commodity (like air which IS however every-where available, not like other products of nature like wood which are NOT every-where available, which are still a "by god given" commodity but have to be PAID for), is therefore a demagogic and untrue statement. The people/consumers always pay for their water: by walking, constructing, manual drawing, etc, or in the case of pressurised pipe systems in the form of levied taxes, which are vague, unseen, indirect, but very much felt AND they are discreminatory: the poor (isolated) people pay the tax (on often essential consumables etc.), which again pays for the construction, operation and maintenance of piped watersupply which these people will however often not receive, so they pay for goods they do not receive and so, in a certain way, cross-subsidise the more affluent sector of society, instead of the way around!

To improve this blind-alley situation of the moment it is thus advocated to make the contact between people : as clients, and the water body: as producer, much more direct with regard to the provision of services, their remuneration and the respective responsibilities for both parties.

The Government will only have to play a restricted role of moderator, for control, audit and planning, as a representative of the people; while the Water Body is expected to manage an efficient and effective service on an economic base. The Government will have as task to scrutinise the Water Body on its efficiency in order to be able to achieve the lowest price for the expected quantity and quality of water supply to the benefited community.

The Government will have the right to increase or decrease the water prices in particular areas of the State in order to be able to manage and influence a well balanced development strategy in the State. Extra water taxes in one region (for example to suppress a too active industrialisation) can be used to support social prices in disadvantageous areas (for example for those areas where desalination treatment has to be carried out in areas predominantly populated by poor people). The Water Bodies will thus retain from the taxed (or subsidized) water charges the revenues necessary for a sound management of the organisation.

The objective becomes now to reform the Water Bodies into organisations orientated on efficiency. One of the attitudes to be changed is the custom to consider all government departments as a kind of hidden "social security" reservoir. If more improvements in the social security system of the country are realised, this tendency will also disappear, signs in that direction are relatively hopeful.

The (re)organisation of the Water Body is to be shaped according to the requirements of optimal task oriented job descriptions and job responsibilities interconnected by schematic flow lines.

It is essential in this context to underline some of the more important exercises and action-sectors for this exercise :

— The general goal and objective of the Water Body will primarily be to serve the public and provide them appropriately with a continued and adequate amount of water of good quality, for the lowest agreed upon price; the Water Body should be (re) structured with this objective in view.

— To this effect the company should work as efficient as possible.

— The personnel department should be upgraded and remodelled.

— The Public Relations Department will have to fulfil a crucial role, in the organisation to ensure, by active awareness programmes, a good and positive understanding :

EXTERNALLY with the :

* State political and administrative systems, to adequately communicate the different problems the drinking water organisation is facing and the effective understanding of the subsequent solutions (with their repercussions) the drinking water organisation is proposing:

* population, consumers and social collectivities at large, to exchange, in a constructive and positive way, experiences and informations particularly also in the socio-economic fields:

INTERNALLY (within the organisation) with the:

* Labour unions,

* employees and their organisation in collaboration with the personnel department.

— The monitoring and evaluation department is to be streamlined and made essential, particularly in the backfeeding process.

— The vigilance section will only be a separate, in principle small, unit as independent as possible.

— The statistical department with the data bank, data centre and data management and information systems, also here the upgrading effect of backfeeding for spiral improvement will be of first importance.

— The Research and Development Unit will have to be an active multi faceted, brainy group each year provided with a certain percentage of the budget to execute investigations of proposals for improvements, and the testing of the incorporation of new technics and developments.

— The Design section will have to be strengthened and should be organized in such a way that a constant output of their own appropriate designs and development activities will be achieved; the surplus-work can be tendered-out as controlled consultancies, so as not under- or overstaff its personnel.

— The operation and maintenance wing will ultimately become the most important part of the activities of the Water Body when the initial spur of the developmental phase flattens-out. O & M costs, as recurrent costs, will contribute mainly to the price-factor per unit of drinking water, due importance should therefore be given to the O & M sector! It is often better to invest more in the initial construction (capital) costs in order to reduce the O & M cost (ask the common man in the street: they will generally go in for the more expensive "good" products than the cheapest ones) then why should a professional company not understand this principle and try to incorporate this factor in their feasibility calculations.

In general the company (Water Body) should become an organisation with a creative, imaginative workforce, which activities will ALWAYS (also in an organisational way) have to pass through a process of creative, up-grading and BACKFEEDING actions and procedures.

The first goal of Water Body (to have satisfied customers) will be easier, quicker and better achieved by a Water Body whose employees have job-satisfaction. It is an established fact in different studies that obtaining of job-satisfaction is a far better incentive for employees, than a hike in salary.

If there is a consensus between the decision makers and the people in general to return to more down to earth and direct management of the drinkingwater sector, the re-organisation procedure has to be executed in a continuous, adaptive, interactive and flexible procedure, supported by professional management institutes. Repercussions of all interventions, re-adaptation and re-training of the workforce, administrative regulations, etc. have to be looked into in all openness, extensive information-cycles have to be organised in a flexible backfeeded programme procedure. The partners in this exercise have to be dedicated to the objective of this exercise and close interactive cooperation is essential.

The cost of this exercise for institutional development has to be supported by state-or national public funds with or without the assistance of multi or bilateral financial institutions.

The exercise will not be able to be conducted by the Water Bodies themselves, but needs to be supported, assisted and guided by knowledgeable professional (government) management institutes and (sub) Consultants.

The result of their consultancy should be directed in such a way that the improvement can be executed in an APPROPRIATE manner: studies/consultancies should not result in academic show-pieces, but in executable projects WITHIN the restrictions of the client's company (within their administrative, personnel and budgetary limitations and restrictions).

It is advocated that the institutional development exercise will first look-into and analyse the most effective, simple and basic structure of the future Water Body's organisation, and only, while implementing this basic framework of the new organisation, will subsequentiy fill-in, in a democratic and flexible way, the different sub-studies and activities successfully, to arrive progressively at an optimum, efficient, self correcting, complete organisation. A one-time academic beautiful elaborated and expensive study, that will create too much of a shock if implemented and thus will be unpractical and remain in the drawers, is only of the value to the Consultant as show-piece and of no practical value to the Water Body. A flexible follow-up of small successively executed, positive experienced, operations will have a much better effect on the future development of the company, although it may not result in some leather-bound impressive reports.

A first initiative according to above ideas may be executed in the context of the Indo/Dutch Cooperation Programme in the drinking water sector in Kerala with the Kerala Water Authority. It will be of interest to the organisations working in the drinking water sector (water bodies, consultants, national, bi- and multilateral agencies) to follow the execution of this Institutional Development Programme, to be able to duplicate, improve and adapt this Programme into endeavours according to their different conveniences and situations, with as result the ultimate goal of a better service to the society.

PAPERS NOT PRESENTED

Financing & Management of Water Supply Projects

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1. GENERAL :

1.1 Water supply and sanitation facilities are the most important utility infrastructure needs for the towns and cities. The objective of the Government of India is to ensure Health for All by the year 2001. The water supply and sanitation decade (1981-90) also had given a thrust to this programme.

To ensure this, it is necessary that all the towns and cities are provided with protected water supply system and sewerage network system or appropriate sanitation facilities. Keeping in view the importance of this infrastructure facility, HUDCO, the premier national techno financing institution in the field of housing and urban development, a Government of India under taking, which has been predominantly financing the housing programmes so far, has opened a new window to finance the urban infrastructure projects. HUDCO would finance the water supply, sewerage and drainage projects under the urban infrastructure component, in addition to roads, solid waste management and other city level infrastucture needs.

2 PRIORITY FOR TAKING UP WATER SUPPLY PROJECTS :

2 1 The Central Public Health and Environmental Engineering Organisation under the Ministry of Urban Development, Government of India has prescribed standards for supply of water to different towns as follows.

For Class I cities – 140 LPCD including distribution losses.

For Class II cities–70 LPCD + distribution losses.

The distribution losses would be about 15 to 20 percent of the total requirement of water calculated on the above basis.

In most of the cities and towns. the present level of water supply is far less than the standard prescribed by CPHEEO. Therefore while identifying the cities for augmentation of water supply system, priority should be given to those cities and towns where the level of water supply is less than the standard prescribed for supplying water, In some of the cities like Delhi, Bombay and Calcutta, the level of water supply is far higher than the standard given keeping in view the perennial river sources from which water is being supplied On the other hand, some of the cities such as Madras the level of water supply is less than 35 LPCD. This also leads to other problems such as blockage in sewage lines when the level of flow is less than dry wether flow

3. INSTITUTIONAL FINANCE FOR WATER SUPPLY PROJECTS :

3.1 For Water Supply Projects LIC has been making available funds. HUDCO'S new infrastructure financing window for financing the urban infrastructure projects, in the 8th plan period is proposed to fund Rs 4000 crores to the various urban development projects and out of this over 60% would be for the water supply and sanitation projects. In the Southern States, HUDCO has already extended financial assistance for some of the important

projects such as Cauvery Water Supply scheme for Bangalore City, Telegu – Ganga Project for Madras city and augmentation of water supply to Chenganacherry, Tiruvalla, and Badagara, Water supply schemes of Madurai, Salem, Attur etc.

International assistance for water supply projects is also available through agencies such as World Bank, UNICEF, IDA, KFW etc

4. IMPLEMENTING AGENCIES FOR WATER SUPPLY SCHEMES :

4.1 STATE LEVEL AGENCIES :

Almost in all the states, there are state level agencies which arrange financial assistance, implement the schemes and also maintain the water supply systems of most of the small or medium towns on behalf of the local bodies. The jurisdiction of these state level agencies may or may not include the metropolitan and other bigger cities/towns. In the southern states the state level agencies for such water supply systems are Public Heath Engineering Dept. in Andhra Pradesh, Karnataka Water Supply and Sewerage Board in Karnataka, Kerala Water Authority in Kerala and Tamil Nadu Water Supply and Drainage Board in Tamil Nadu State Level Water Supply Boards are in existence in Maharashtra, Gujarat, Punjab, Uttar Pradesh etc. These agencies generally implement the projects as deposit works on behalf of the municipalities. Collection of revenue in some of the cases is with the municipalities and in certain cases it is with the water supply authority itself. Therefore, the policies for maintenance and collection of revenue is different in respect of different states.

4.2 CITY LEVEL AGENCIES :

For the metropolitan cities such as Madras, Bangalore and Hyderabad there are exclusive agencies like Madras Metro Water Supply and SewerageBoard in Madras, Bangalore Water Supply and Sewerage Board in Bangalore and Metro Water Supply Board in Hyderabad for implementation of projects, and operation and maintenance of the water supply system International and other financial institutions assistance is also made available to these agencies directly. There are also city level agencies implementing the water supply projects such as Development Authorities, Municipal Corporations, Municipal Councils, Cantonment Boards and Improvement Trust.

5. HUDCO'S FINANCIAL ASSISTANCE FOR WATER SUPPLY PROJECTS:

5.1 The Housing and Urban Development Corp. (HUDCO) established in 1970 has been financing housing and small level urban development projects. HUDCO after opening its new window for financing urban infrastructure projects, has financed Rs. 184.28 crores for the urban development projects. HUDCO's financial assistance for water supply projects at the layout level, city level and inter-city level can be made available to agencies such as state urban finance corp., state municipal development agencies, state functional agencies for housing, various urban services and transport, development authorities including national capital region board, municipal corporations and municipal councils, cantonment boards and other local bodies, improvement trusts etc HUDCO would also consider co-financing of projects along with other agencies on agreed terms.

6 HUDCO'S TERMS OF FINANCING:

6.1 HUDCO encourages projects which are technically sound and financially viable. HUDCO financial assistance for water supply projects are made available at 11.5% for towns having population more than 10 lakhs and for bigger towns where population is more than 10 lakhs, with the rate of interest chargeable at 15%. However, if a comprehensive scheme is prepared where portion of the bulk supply caters to the wayside municipalities the same can be quantified and proportionate loan can be considered at 11.5% rate of interest. HUDCO's financial assistance is normally limited to 70% and the remaining 30% have to be met from other sources such as State Goverment funds, finance from other institutions etc. Arrangements for 30% assistance is to be clearly identified before sanctioning of HUDCO loan. HUDCO allows repayment period of 15 years which also includes the moratorium period. The moratorium period is

the construction period during which only interest is to be paid to HUDCO and repayment of principal will be done after completion of the project. The interest accrued during construction is capitalised, and included in Project Cost, on which also HUDCO loan is made available.

7. PROJECT FORMULATION :

7.1 PLANNING & FINANCING PROPOSAL:

In order to obviate infructuous work and delays due to detailed scrutiny of the project proposal to a decision on its viability, HUDCO accepts a Planning and Financing Proposal (PFP) prior to furnishing the detailed project report and loan application which would contain the following particulars :

a) Description of the city and sector of assistance and the ongoing developments of different agencies.

b) Master Plan Regulations pertaining to urban development of the site.

c) Type of contemplated development i.e. utility, social and commercial infrastructure proposed to be developed. The planning approach with conceptual designs and sketches of the proposed development.

d) Approximate cost of the total project and loan amount.

e) Details of financial performance over the last five years in terms of expenditure and revenue on capital and revenue budget level of taxes and user charges etc

The PFP will be scrutinised by HUDCO's Urban Infrastructure Project Evaluation Committee in consultation with the borrowing agency If it is approved in principle, with or without modification, the borrowing agency will be asked to submit a detailed proposal with documentation charges normally within 6 months This will help the agencies to advance planning preparation and avoiding documentation delays as well as make the technical interaction more meaningful. However, if the agency prefers to furnish the complete loan application in the first instance it would be free to do so.

7 2 DETAILED PROJECT PROPOSAL :

If Planning and Financing Proposal (PFP) of the borrowing agency is approved for financial assistance the borrower would prepare and attach a detailed project report in the form of an operational action plan taking into account the following information depending on the type of scheme proposed :

1 Detailed reasons for initiating the proposed scheme.

2 Conformity with the Master Plan/interim development plan for the area.

3. General topography of the scheme area.

4 The essential infrastructure available in respect of the proposed sector and project area at present indicating the present standards as well as the proposed standards.

5. Sources of existing water supply, electricity, etc. depending on the items of infrastructure proposed for increasing their present distribution pattern and potential for their augmentation.

6 Existing sewage collection/disposal, solid waste disposal, sanitation and drainage system and proposed future plans in the case of sewerage and sanitation.

7 Existing transportation pattern and proposed expansion in future, in the case of transportation projects.

8. Details of urban infrastructure schemes completed in the recent past and schemes in progress with the assistance of Central Government, State Government, LIC, UA etc

9 Coordination of the development works within the frame work of the approved Master Plan.

10. Climatic conditions of the area, drainage problems, ariation in subsoil water level

during the year, danger of flooding, etc. as may be relevant.

11. Whether land acquired and compensation paid

12. Details of adoption of latest technology and/or use of local materials and techniques.

13. A description of the entire proposal with respect to location, site, design, specification, calculation, drawings etc.

14. Urban design and architectural quality of administrative buildings, headworks, recreation facilities, landscaping, works of art etc.

15. Allowances made for physical contingencies and uncertainties in detailed estimates. The project should preferably be capable of being completed within three years without any need for provision for escalation.

16. Provision for operation and maintenance of the infrastructure items to be funded in terms of the agecy's responsibility and levy of user charges. Justification should be given where full operation and maintenance cost and debt servicing is not proposed to be recovered.

8 PROJECT EVALUATION:

8 1 Once a detailed project proposal is received, the same will be examined at three levels, (1) by the HUDCO inhouse appraisal team (2) by an expert member in the appropriate field who is conversant with the local conditions (3) the project along with the expert opinion and the appraisal points would be presented to the urban infrastructure project evaluation committee which consists of experts in the field of water supply. The committee accords technical clearance for the project before sanctioning of the same by HUDCO.

8.2 In the scheme application, the physical progress projected in the Bar/CPM chart is converted into a financial progress and cash flow for the scheme both from HUDCO as loan and from other institutions are clearly identified.

9. SECURITY FOR HUDCO LOAN:

9.1 Loan advanced by HUDCO have to be secured either as unconditional and irrecoverable bank guarantee from a scheduled bank acceptable to HUDCO or a State Government Guarantee. As per RBI guidelines, State Government Guarantee is permissible only for loans carrying interest less than 11.5%. Therefore for schemes taken up in major cities having population more than 10 lakhs, a bank guarantee would have to be made available being the rate of interest 15%. This involves additional burden on the implementing agency as they have to pay quarter to half percent towards bank commission for the guarantee. Some of the agencies are reluctant to give bank guarantee due to this additional expenditure. The subject has been taken up with RBI anb RBI gives exemptions based on special request many of the schemes for providing Government Guarantee.

9 2 In the case of Telegu Ganga Project of the Madras Metrowater Supply and Sewerage Board, such exemption to accept State Govenment Guarantee has been given by RBI. However, this exemption is limited only for a period of two years and the Madras Metrowater Supply and Sewerage Board is expected to switch over to mortgage of properties or other guarantees after the expiry of this two years. While such a clearance is presently acceptable for completion of documentation it has got to be examined in the larger context i.e. after the completion of two years HUDCO would have released all the moneys sanctioned for the project and the State Government Guarantee would have expired by then and therefore HUDCO would have to again follow up with the agency for getting suitable security for this loan. Therefore this is an area to be sorted out with RBI, State Government and Implementing agency.

10. DOCUMENTATION CHARGES/SERVICE CHARGES :

10.1 HUDCO charges three tier documentation charges depending on the quantum of loan as indicated below :

Loan amount	Documentation charges
upto Rs. 2 crores	Rs. 10,000
above Rs. 2 crores but less than Rs 5 crores	Rs. 15,000
above Rs. 5 crores	Rs. 20,000

10.2 Service charges of 0.5% on the total loan amount is also chargeable for all the schemes financed by HUDCO. This amount would be recovered while loan is released in instalments.

11. TENDERING :

11 1 Water supply projects generally involve competitive bidding including international bidding. For this, shortlisting of contractors is to be carried out first before tendering Shortlisting of contract involves prequalification of contractor for bidding International financing institutions also insist for International Competitive Bidding for major contracts After the process of shortlisting, NIT, tender finalisation and award of work, consumes considerable time, some of the cases it is one year or more. Therefore, there is a need for streamlining this procedures i e. at the time of project formulation itself some of the areas such as shortlisting of contractors, preparation of tender schedules, based on available information etc. can be completed.

12. IMPLEMENTATION OF THE SCHEME AND FLOW OF FUNDS :

12 1 The loan drawal and repayment schedules are decided alongwith scheme application. The loan drawal is linked with the implementation of the scheme. For this purpose, the financial progress based on the pert/bar chart for the implementation of the scheme HUDCO loan release is generally made on quarterly basis, keeping in view the physical and financial progress to be achieved in the ensuing three months. The first instalment of loan is released on execution of the agreement and necessary securities are made available. Subsequent instalment will be released based on achieving adequate physical and financial pogress utilising funds released by HUDCO and also mobilising additional funds as envisaged in the project. In order to monitor the progress of the schemes, quarterly progress report will be made available to HUDCO which is evaluated by the appraisal team and a report on the progress in terms of cost over run and time over run is made available to the implementing agency to work out corrective measures for speeding up the project.

13. PROBLEMS ENCOUNTERED IN IMPLEMENTATION OF THE PROJECTS :

13 1 Generally problems that hamper the progress of water supply projects are related to

a) land acquisition for pump house, staff quarters, treatment plants etc.

b) permission for river crossing, railway crossing, road crossing from the respective authorities and synchronising implementation of this works in consultation with the movement of traffic etc.

c) ecological constraints.

d) availability of materials.

14. COST RECOVERY :

14.1 Revenue to the water supply systems is by sale of water and service connection charges. The service connections are charged depending on the characteristics of the consumer i. e individual houses, group houses, layouts, commercial establishments, institutions, industries and other bulk consumers. Similarly, water tariff is different for domestic use, commercial use, industrial use and institutional use. The tariff is also different depending on the quantum of supply. For an initial slab the rate is fixed and for any additional quantity, the slab rate would be higher than the basic slab rate. In order to implement this, all the connections are to be metered. At present, there are large number of unmetered connections particularly for the domestic supply and therefore, the water charges for these unmetered connections are based on a lump sum rate The water tariff and water connections charges are periodically revised keeping in view the operation and maintenance cost for the water supply system. This also involves policy decision at the state goverment level. The prevailing water tariff rates in Madras are as follows :

	Rate per 1000 lit.
Domestic	Rs 1.20
Commercial	Rs. 3 60
Industries	Rs. 12 00
Port Trust	Rs. 8 40

These rates are only basic rates and depending on the consumption the unit rate will be increased appropriately.

There are arrangements in some states to give supply to bigger level agencies like Central Government undertakings, Government Departments like Defence, Railways, Housing agencies at external peripheral service level.

15. RATES AND USER CHARGES :

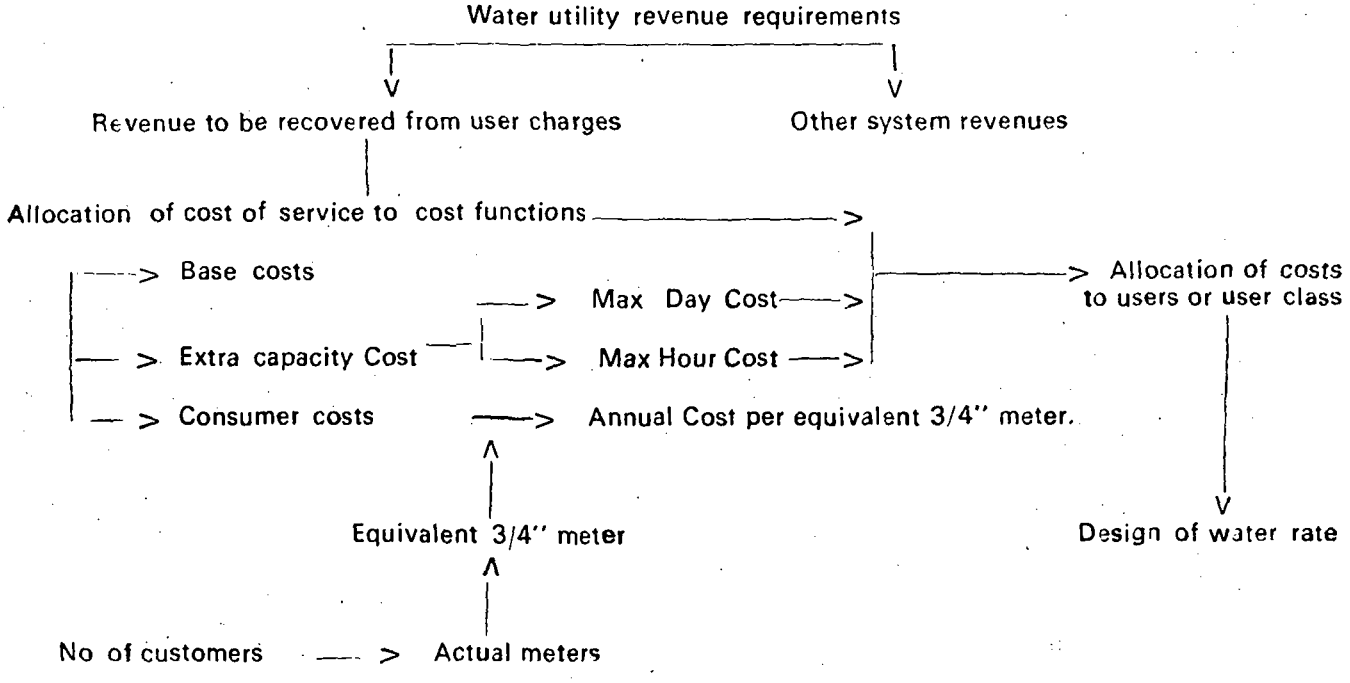
15.1 The setting of rates and user charges has become an important problem for all types of urban water systems. The rate setting process consists of three parts :

1. Determination of revenue requirements or the cost to operate the system. This will include cost estimates for a few years into the future, say 5–10 years with appropriate allowances for depreciation and inflation. There may be some funds built in for capital improvements and major repairs, as well as debt retirement that has been made necessary by the previous borrowing.

2. Determination of the cost service by customer class.

3. Actual design of the rate structure itself.

To make the charge system more equitable and at the same time, more conserving and promote green lawns in the city on a reasonable basis. It should begin with an analysis of rate structures We have to follow the procedure given below.



Schematic Development of water Rates *

* Neil S Grigg, Colorado State University, Fort Collins
"URBAN WATER INFRASTRUCTURE Planning, management and operations."

Economics of Metering in Rural Water Supply System - A Case Study

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In the beginning of year 1982 the Uttar Pradesh Jal Nigam had undertaken study of water consumption and other para-meters in three selected rural water supply system and it is still continuing. Prior to undertaking the study the water supply in all these villages was intermittent, but was made continuous to make the study meaningful. Out of three, in two systems all connections were provided with water meters. In the third, metering was not done so as to compare the consumption and other factors.

In this paper the author presents the effect on consumption of water through household connections on metering based on the recorded consumption figures for a period of 8 years. The average consumption of water in metered connections was about 60 litres per capita per day which is well within the accepted norms and about 40 percent of that in unmetered ones. The question of metering has all along been controversial. Based on the actual data of study, available and adopted norms and some assumptions made in working out the cost for metering. It is revealed that supply through metered connections is economical than in unmetered systems. Obviously the situation in urban areas will be more alarming when metering is not practiced.

1. INTRODUCTION

Safe, adequate and reliable water supply at a minimum cost is the prime objective of any system. Only continuous supply can ensure safety by way of keeping adequate pressures in the distribution system to avoid contamination from outside and making water available round the clock, to upgrade its hygienic quality and safe guarding against the risk of fire. It is also well established that unless all connections are provided with meters, the system cannot practically be run on continuous basis at reasonable / accepted norms of water supply. If an unmetered system is required to be run on continuous basis the consumption per capita becomes excessive and goes beyond resources. The rural water supply systems are no exception to this.

Almost all rural pipe water supply system in India have intermittent supply, period ranging from half an hour to 8 hours per day. This has been mentioned in the evaluation report on rural water supply schemes by the National Environmental Engineering Research Institute, Nagpur, published in the year 1980-81.

In order to ascertain actual consumption, fluctuation in demand during different period, socio-economic conditions etc. and then to frame realistic water tariff, the Uttar Pradesh Jal Nigam, has selected some small urban and rural water supply system in Bundelkhand area of the province. The selected area is fair representation of typical water scarcity, hot climate and general socio-economic conditions in the country. The studies in the area were started in the Year 1980-81 by a special unit named as "Tariff unit, Jhansi."

2. LOCATION & SALIENT FEATURES OF VILLAGES SELECTED

The study was conducted in following villages/group of villages which form part of the bigger three groups of villages in Bundelkhand area of Uttar Pradesh.

(i) Bijauli (District Jhansi) is one of the 14 villages of Jhansi-Babina group of villages, getting water from Matatila dam commissioned in the year 1967. The present population of the village is about 2540 located at a distance of about 10 kms. from Jhansi town and well connected by road and railway from Jhansi to Babina.

(ii) 7 villages viz. Kitkhiyai, Tekari, Khadesra Kala, Pawa, Nato, Kurmai and Banota (District Lalitpur) are part of Talbehat group of 8 villages which also get water supply from Matatila dam with separate treatment works. These are located about 50 to 55 kms. from Jhansi on way to Lalitpur. The present population of these villages is about 4401.

(iii) Bahadurpur and Bachrawani (District Lalitpur) are villages of Maharauni and Madaura group of 36 villages which get water from Jamni dam. The water supply was commissioned in the year 1971. The present population of these two villages is about 1872, and are located in an interior area which is about 170 kms. from Jhansi and 70 kms from Lalitpur, having about 8 kms. of dry weather road. The study of these villages were not conducted in the year 1989 as some unsocial elements disturbed the water supply for this village. Due to irregular water supply it was not found fruitful to continue the study of this scheme. Now the situation has improved and study will be continued.

The maintenance of water supply in all the group of villages is being done by the Jhansi Division Jal Sansthan which is an autonomous loca body entrusted with the task.

3. METHODOLOGY

Before the study was started water was being supplied through connections which were not metered and the period of supply varied from 4 to 6 hours per day. In order to study the effect of metering all connections in the selected villages of Jhansi, Babina and Talbehat groups were first provided with water meters and then bulk meters were also installed to measure the total supply. The two villages of Maharauni and Madaura group were selected for studying the effect of unmetered supply. Door to door survey was also carried out to know the number of persons benefited by each connection, their socio-economic conditions, etc. by the staff of the Tariff Unit, Jhansi.

THE OBJECTIVES OF THE STUDY INCLUDED:

(a) Consumption of water through connections and standposts.

(b) Variation in hourly, daily, monthly and seasonal demands.

(c) Unaccounted for water through wastage, leakage, pilferage and to suggest ways and means to reduce it.

(d) Performance of water meters and their maintenance/repair cost.

(e) Effects of other sources of water on the number of private connections.

(f) Consumption rate of water by different income groups.

Initially, for one year, hourly consumptions at all the three groups were recorded. Later, hourly recording was discontinued in case of Bijauli and Maharauni Madaura groups. The monthly readings of all meters provided on private connections and daily consumption of all bulk meters are being taken by the Jal Nigam staff and results tabulated to assess actual consumption and wastage of water.

In order to know the performance, cost of repairs, frequency of break-down, etc. of water meters, 36 water meters of 7 manufacturers are under observations since January, 1982. To have more representative idea of the cost of repairs of water meters in service for a longer period, the statistics of repairs carried out at other workshop have also been considered.

4. FINDINGS

1. The quantities of water consumed in metered and unmetered supplies have been tabulated Table 1 (a), 1 (b), 1 (c). In case of metered supply the per capita consumption ranged from 42 to 77 and in unmetered from 103 to 154 litres per day. Thus in unmetered supply where additional precautions were taken to stop leakages and consumers persuaded to avoid wastage, the rate of consumption was about 250 percent higher than that in metered supplies. This is because of the fact that in case of unmetered supply the consumer pays only fixed charges irrespective of the water actually consumed.

2. The studies confirm that in rural areas water can easily be supplied on continuous basis at lesser per capita rate than normally designed rate of 70 to 90 l pcd when metering is resorted.

3. In metered supplies the number of house connections increased by about 80 percent in a period of 8 years while in unmetered supplies there has been no increase. Though exact reasons for this abnormal phenomenon could not be known, however, it is partly explained by the fact that average number of persons served, per connection in this category is 13 as against 7 in metered supply.

4. The average chance of breakage based on studies over a period of 8 years, repairs of water meters works out to 33.68% per year (Table-II). However to be on safer side and considering more likely frequent break down in the later years, the average breakdown has been taken as 50% for working out the economics of metering.

5. Against the cost of metering as Rs. 8.60 per connection per month (Annexure A) the cost of extra water supplied in unmetered connection works out to Rs. 19.75 (Annexure B). This clearly shows that metering is much cheaper besides having the advantages of not making unnecessary investment in capital works and forcing the consumers to conserve the commodity which is getting scarce day by day in view of the increased needs.

5. SUMMARY & CONCLUSIONS

The studies undertaken by the Jal Nigam are of pioneering nature and have established, contrary to belief and trend, that rural water supply systems can conveniently and economically supply water on continuous basis within reasonable and normally adopted per capita rate of water, provided all connections are metered and charged according to the actual quantity of water consumed.

Metering has further advantages of charging the consumers on equitable basis, provides information about wastage of water, indicates trend in consumption of water thereby helping in future planning, provides basis data for framing the water tariff, ensures, supply to all beneficiaries at reasonable pressure and finally becomes a handy tool for conservation of water, particularly in scarcity.

The Jal Nigam is continuing the study of the selected areas, for collecting data on long term basis.

Cont:-

TABLE - 1 (A) DETAILS OF WATER CONSUMPTION

Sl. No.	Name of Group Category/ Year	Talbehat/metered							
		1982	1983	1984	1985	1986	1987	1988	1989
1	2	3	4	5	6	7	8	9	10
1.	No. of villages studied	5	5	5	5	6	6	7	7
2.	Total population	3405	3475	3546	3618	4048	4048	4315	4401
3.	No. of connection	66	68	74	76	92	102	117	133
4.	Population actually served.	506	521	560	575	853	956	1605	1735
5.	Hours of supply	24	24	24	24	24	24	24	24
6.	Average water supply per day (Kls)	47.2	43.5	46.7	56.5	121.45	130.52	163.29	266.70
7.	Average water actually consumed per day (Kls.)	28.3	26.1	28.0	33.9	58.24	70.33	96.24	133.10
.8	Average water actually consumed per capita/day (lpcd)	56	50	50	59	69	74	60	77
9.	Average consumption per capita per day over a period of 8 years (lpcd).			62					

TABLE—1 (B) DETAILS OF WATER CONSUMPTION

Sl. No.	Name of Group Category/Year	Bijauli Metered 1982	1983	1984	1985	1986	1987	1988	1989
1	2	3	4	5	6	7	8	9	10
1.	No. of villages studied	1	1	1	1	1	1	1	1
2.	Total population	2288	2343	2391	2440	2440	2440	2490	2540
3.	No. of connection	65	72	77	83	86	94	99	105
4.	Population actually served	597	648	680	718	744	871	919	950
5.	Hours of supply	24	24	24	24	24	24	24	24
6.	Average Water Supply per day (Kls.)	33.6	38.4	46.3	60.3	59.74	67.65	66.97	77.87
7.	Average water actually consumed per day (Kls.)	25.1	29.3	34.7	45.2	42.79	51.47	50.77	58.15
8.	Average water actually consumed per capita/day (lpcd)	42	45	51	63	58	59	56	62
9.	Average consumption per capita per day over a period of 8 years (lpcd)			55					

TABLE—1 (C) DETAILS OF WATER CONSUMPTION

Sl. No.	Name of Group Category/Year	Bahadur pur & Bachhrawani un-metered 1982	1983	1984	1985	1986	1987	1988	1989
1	2	3	4	5	6	7	8	9	10
1.	No. of villages studied	2	2	2	2	2	2	2	
2.	Total population	1295	1321	1348	1375	1835	1835	1835	
3.	No. of connection	31	31	31	31	32	32	33	
4.	Population actually served	396	396	396	396	459	459	467	
5.	Hours of supply	24	24	24	24	24	24	24	
6.	Average water supply per day (Kls.)	102.2	93.1	68.5	80	88.02	41.96	55.11	
7.	Average water actually consumed per day (Kls.)	61.3	55.9	41.1	48	—	—	—	
8.	Average water actually consumed per capita/day (lpcd)	154	141	103	121	193	91	120	
9.	Average consumption per capita per day over a period of 8 years (lpcd).			132					

TABLE-II

STATEMENT SHOWING THE FREQUENCY OF BREAK DOWN OF WATER METERS.

Sl. No.	years	No. of Meters	No. of break down	Percentage of break down (%)
1	2	3	4	5
1.	1982	36	NIL	Zero
2.	1983	36	9	25
3.	1984	36	15	41·6
4.	1985	36	8	22.2
5.	1986	36	17	47.22
6.	1987	36	14	38.89
7.	1988	36	22	61.11
8.	1989	36	12	23.33
	TOTAL	288	97	33.68

POSITION OF WATER METER BREAK DOWN OF DIFFERENT COMPANIES

Company	No. of water meter installed.	Year/No. of Break Down									
		1982	1983	1984	1985	1986	1987	1988	1989	Total	No. of break down per year.
2	3	4	5	6	7	8	9	10	11	12	13
A	5	-	-	-	-	1	-	2	-	3	7.5
B	5	-	-	1	2	1	1	1	-	6	15
C	5	-	4	3	1	8	4	3	5	28	70
D	5	-	1	3	1	1	5	4	3	18	45
E	5	-	2	2	1	1	2	3	3	14	35
F	5	-	-	3	2	4	2	6	1	18	45
G	5	-	2	3	1	1	-	3	-	10	25
H	1	-	-	-	-	4	-	-	-	-	-
Total:-	36	-	9	15	8	17	14	22	12	97	33.68

Note :- 1. 3. meters of company (A) have not gone out of order over a period of 8 years.

2. Meters of Company (B) have gone out of order only once over a period of 8 years.

3. Out of 36 meters in use for 8 years only 3 meters (2 of company (C) and one of Company (F) came irrepairable. This works out to be 1% per year.

ANNEXURE-A

COST OF WATER METERING

The Cost of metering includes the following components :

1. Repayment annuity of the cost of water meter and its installation including safety box.
2. Annual repair charges.
3. Reading and billing.

The average cost of the above compoents are as below:-

(i) ANNUITY:

(a) Cost of water meter.		Rs. 200
(b) Fittings & fixing		Rs. 20
(c) Safety Box		Rs. 30
	Total:-	Rs. 250

Taking average life of water meter as 10 years and loan to be repaid in 10 years with an annual rate of interest of 10%

Annuity of Rs. 250.00 = 250 x 0.16275 = Rs 40.68

Which is equal to about Rs. 3.39 to be paid monthly.

(ii) ANNUITY REPAIRS.

Unit – 4 Nos.

(a) Taking out and refitting Assuming that one plumber can attend 4 such meters per day average cost =		Rs. 35.00
(b) Transportation charges from consumers to workshop & back =		Rs. 15.00
(c) Repairs on materials and labour =		Rs. 80.00
	Total:-	Rs. 130.00

$$\text{Total cost/meter} = \frac{130}{4} = \text{Rs. } 32.50$$

Presuming that on an average a meter needs repair/servicing once in two years monthly cost of repairs will be:

$$\frac{32.5}{2 \times 12} \quad \text{Rs. } 1.35$$

20% over head charges ; net = $1.35 \times \frac{20}{200}$ = Rs. 0.27

Average cost of repair/meter/month = 1.35 + 0.27 = Rs. 1.62

ANNEXURE-B

COST OF EXTRA WATER CONSUMED IN UNMETERED SUPPLY

The extra cost of water consists of components of capital works and production of water

(A) CAPITAL COST

The study reveals that the actual consumption is 60 lpcd while that is 130 lpcd in an unmetered connection.

Taking average capita cost of production.

(i) For 70 lpcd — Rs. 400/capital
(ii) For 130 lpcd — Rs. 600/capital

Extra capital cost of production in an unmetered supply per connection for a family of 7 persons = Rs. 200 x 7 = Rs. 1400
Loan to be repaid in 30 years in equal yearly instalments annual rates of interest @ 10% (the life of the work is taken as 30 years.)
Annuity per connection = (.10608 x 1400) = Rs. 148.51 per year
Rs. 12.38 per month

(B) COST OF WATER

Quantity of extra water per connection/month = (130-60)
× 30 × 7
= 1470 litres

Assuming average cost of production is Rs. 0.50 per 1000 litres, the cost of extra quantity of water per connection per month =

$$\frac{14700}{1000} \times 0.50 = \text{Rs. } 7.35$$

Total cost per month per connection = (A) + (B) = 12.38 + 7.35 =
Rs. 19.73
Say Rs. 19.75

Net saving per connection per month = Rs. 19.75 — 8.60 = Rs. 11.15
Say Rs. 11.00

(iii) READING AND BILLING

The calculations are based on experience that a meter reader-cum billing clerk can complete about 15 meters per day. The working days are taken as 20 in a month and billing is done on bi-monthly basis. The monthly cost works put;

Salary of person =	Rs. 1000.00
Travelling & other expenses (L.S.)	Rs. 300.00
Total :-	Rs. 1300.00

Monthly cost of billing as per meter = $\frac{1300}{15 \times 20 \times 2}$ Rs. 2.43

Level supervision&office expenses —
Say 20 % = 1.43
Net cost of metering/month/meter = 7.17 + 1.43 = Rs. 8.60

Development of Traditional Water Sources For Drinking Water Supply Among Weaker Sections

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ABSTRACT

This paper is concerned with a number of groundwater based pilot projects which were implemented for the benefit of weaker sections like Harijans and Tribals living in Thekkumkara Panchayat and Attappady Valley. All these pilot projects involved the development of traditional water sources like dugwells, springs and borewell hand pumps. The active involvement of the beneficiaries in the implementation of all the pilot projects was ensured. The support of non-governmental voluntary organisations active among the beneficiaries was also taken. All the pilot projects which were implemented at relatively low costs were found to be extremely beneficial to the weaker sections living in the project area. These pilot projects also have considerable scope to be replicated elsewhere.

1.0 INTRODUCTION

Improvements were made in the drinking water supply, conditions within a project area comprising of Thekkumkara Panchayat in Trichur District and Attappady valley in Palghat District. There are a number of harijan colonies in Thekkumkara Panchayat. The Attappady Valley is predominantly inhabited by tribals. These weaker sections were experiencing acute drinking water scarcity. The improvements in drinking water supply were achieved through the implementation of of a number groundwater based pilot projects. In order to be successful any such water supply scheme should be simple enough to ensure the participations of the beneficiaries in its implementation and subsequent operation and maintenance. Scientific development of traditional water sources assume considerable importance and relevance in this respect. The direct involvement of non-governmental voluntary organizations who are active among the beneficiaries can to a large extent ensure the success of these pilot projects. A voluntary organisation called 'COSTFORD' was found to be active in Thekkumkara Panchayat. Another similar organisation called 'NATURE' was found to be active in the Attappady valley. These two voluntary organisations were closely involved in the implementation of the pilot projects.

The pilot projects which were implemented can be broadly classified as follows :

* Renovation of existing poorly maintained panchayat wells and unhygienic pits as clean drinking water sources.
* Developing natural springs for community water supply
* Drilling of borewells and fitting them with hand pumps.

2.0 RENOVATION OF PANCHAYAT WELLS AND PITS

During the field surveys the investigating team noticed that there were a number of panchayat wells which were either abandoned or were in a poor state because of no proper maintenance. It was also noticed that there were also a number of pits which were being used under unhygienic conditions. These existing sources had considerable scope to be properly developed as clean drinking water sources.

In some instances these existing sources had to deepened to ensure sustained water supply. The scope for further deepening was first ascertained through geophysical surveys. At some locations where deepening was found to be possible, it was also noticed that the sides of the wells had to be protected either with laterite brick wall lining or with cement concrete rings. Convenient facilities for manual lifting of water with the help of pulleys had to be provided at all the sites.

A total of fourteen such pilot projects were implemented in the project area. Five of them were within Thekkumkara Panchayat. These were at Thekkumkara Harijan Colony, Thekkumkara South Harijan Colony, Karumathara (2 numbers) and Vattappara. The remaining nine were in the tribal hamlets within Attappady valley. These were at Melemully, Cholakad, Mamanaooru, Manthimale, Pettikkal, Goolikkadavu, Karara, Pothuppady and Nellipathiooru respectively.

The extent of deepening and side protection measures varied from site to site. Consequently the cost of each of the 14 pilot projects was also different. It ranged between a maximum of Rs. 8,000/- and a minimum of Rs. 1,400/-. All the 14 pilot projects could be implemented at a total cost of about Rs. 45,000/-. This suggests that it is possible to renovate existing poorly maintained panchayat wells and unhygienic pits in the project area at an average cost of about Rs. 3,500/- at each site.

The 14 pilot projects which were implemented in the project area now benefit more than 300 families who were previously experiencing acute drinking water shortage. There is considerable scope for renovating and improving similar existing wells and pits in other parts of the project area as well as outside of it.

3.0 DEVELOPMENT OF NATURAL SPRINGS

3.1 GENERAL

There are a number of places in the project area where natural springs were found to have considerable scope to be properly developed as good drinking water sources. Some of these springs were found to be presently used but the use was mostly inefficient due to several reasons. Some of them are given below:

* The women who collect the water from the spring mouth have to invariably undergo the drudgery and of physical strain of walking about 0.5 to 1.0 km and climbing a height of about 50 metres.

* The women have to spend considerable waiting time to collect the water and also most of the spring water is being discharged wastefully below because there is no storage facility.

* In some cases cattle are also found to frequent the spring mouth which makes the source unhygienic for human consumption.

Springs if properly developed have several advantages as source of drinking water supply schemes. Some of these advantages are given below:-

* A simple gravity distribution system of without costly energised pumps can be used to reach the spring water close to the place where the people live. The operation and maintenance of the water supply scheme is also therefore very simple.

* The spring water is mostly of very good quality and no costly treatment processes are required.

The development of natural springs as source of community drinking water supply was successfully demonstrated in the project area through the implementation of a pilot project at the Gonjiyoor tribal hamlet in Sholayur panchayat of Attappady Valley.

The Gonjiyoor tribal hamlet has 45 tribal families belonging to Irula community. Like all other areas in the rain shadow region of Palghat District, Gonjiyoor also experiences acute water scarcity during summer months. The investigating team noticed that there was a natural spring close to the hamlet. The spring discharge was periodically monitored to evaluate the quantum of water which can be supplied. The results indicated that typically the spring discharge was about 45,000 litres/day (lpd) during the monsoon, about 35,000 lpd during early summer and about 25,000 lpd during peak summer. The discharge even during the peak summer was found to be adequate to cater to the needs of all the 45 tribal families in the hamlet if the spring could be properly developed.

3.2 DETAILS OF THE PILOT PROJECT

The spring based water supply scheme which was implemented as a pilot project at the Gonjiyoor Tribal Hamlet consists of the following major components:

* Improvements at the spring mouth and provision of a collection cum sedimentation tank close to the spring mouth.
* Construction of the filter and the distribution tanks.
* Laying of service pipe and provision of public utility taps close to the tribal hamlet.

A small water pool was made in the flow path of the spring near its mouth with a cement concrete obstruction. The spring water from here was tapped using a 20 mm diameter galvanised iron (GI) pipe and delivered into a collection tank. The distance between the spring mouth and collection tank was 15 metres. A gate valve was provided in this segment of GI pipe so as to control the flow into the collection tank.

The collection tank into which the spring water was delivered was cylindrical in shape and of size 1.2 m diameter and 1.0 m depth. It was made in reinforced cement concrete (RCC). The spring water was found to carry sediments. The collection tank in addition to providing storage also functions as a sedimentation tank.

The coarse sediments which collect at the bottom can be periodically removed. The tank was covered with a GI wire mesh.

The spring water from the collection cum sedimentation tank which is free from coarse sediments was delivered into a filter tank through a 12 mm GI pipe burried under the ground. The pipe length between the collection cum sedimentation tank and the filter tank was about 75 m. The filter tank was cylinderical in shape and of size 1.2 m diameter and 3.5 m depth. It was constructed in RCC. The filter materials used were locally available charcoal, pebbles and fine river sand. Charcoal which was kept at the bottom of the filter tank was 0.3 m thickness. A layer of 0.3 m thickness of 40mm pebbles and a layer of 0.3 m thickness of 15 mm pebbles were kept over the charcoal. 0.15 m thickness of river sand was kept at the top. The total thickness of the filter materials is 1.05 m. The top 2.45 m of the filter tank was clear space into which spring water from collection cum sedimentation tank was delivered. A gate valve was provided in the GI pipe before the filter tank so as to control the flow into the filter tank.

The spring water from the filter tank which is now also free from finer sediments was delivered into a distribution tank which was constructed adjacent to it. The distribution tank was cylinderical in shape and of size 1.2 m diameter and 2.5 m depth. It was constructed in RCC. The service pipe was taken from the distribution tank. A gate valve was provided at the outlet from the distribution tank.

Overflow arrangements and outlets at the bottom for cleaning were provided in both the filter and distribution tanks. Both tanks were constructed in such a way that the bottom 1.0 m of each was below the ground level. Both tanks rest over 2.45 m thick foundation concrete. A retaining wall in random rubble masonry about 1.25 m height was constructed all around the filter tank and the distribution tank for better stability of the two structures. Welded iron mesh covers were used for both the tanks.

The spring water collected in the distribution tank was taken close to the tribal hamlet through a 12 mm GI service pipe buried underground. The length of the service pipe was about 150 m. A raised platform in random rubble masonry was constructed at the end of the service line and five public utility taps in series were provided in the platform.

3.3 COST OF THE SCHEME

The spring based water supply scheme involved expenditure towards the following major components of work:

* Construction of collection cum sedimentation, filteration and distribution tanks as well as a platform for providing the public utility taps.
* Procurement of GI pipes, specials, taps, welded wire mesh and filtering materials.
* Labour charges for laying of service line.

The expenditures incurred for each of the above three items of work were Rs. 9,475/–, Rs. 8,400/- and Rs. 325/- respectively. The total cost for

implementing the scheme was therefore Rs.18,200/- (Rupees eighteen thousand and two hundred only).

3.4 BENEFITS DERIVED

The feasibility of developing natural spring as efficient source of community water supply in the project area was successfully demonstrated through the implementation of this pilot project. The beneficiaries could be motivated to actively participate in the implementation of the pilot project. The total cost of the water supply scheme was only Rs. 18,200/-. It was found to benefit more than 45 tribal families who were previously facing acute drinking water shortage. The drudgery and physical strain which the women in the area had to previously undergoing walking more thah 0.5 km and climbing a height of 50 metres to reach the spring source were also removed. There is also adequate scope to replicate such schemes in other parts of the project area and also outside of it.

4.0. BOREWELLS FITTED WITH HAND PUMPS

There are many places in the project area where hand dug wells as source of drinking water supply may not be feasible. Some of the reasons for the same are given below:

* The unconsolidated overburden in which the hand dug wells are to be constructed may be very shallow because of which the hand dug wells cannot be dug to adequate depths.

* Although adequate depths of unconsolidated overburden may be available, the water table may be very deep and the hand dug wells constructed in those place may go dry during summer.

In some places like those mentioned above, the bed rock underlying the unconsolidated overburden may have fractures at different depth horizons. These fractures may contain water which can be tapped through bore wells. Some of the important features of such bore wells are:

* They are usually drilled to a depth between 50 and 70 metres using a down the hole hammer (DTH) type of rig.

* The overburden portion of the drilled hole is cased with a blind casing pipe which rests firmly on the hard rock below. This prevents the sides of the well from collapsing.

* The remaining portion of the drilled hole in the hard rock is left naked and groundwater enters the bore well through the fracture horizons which are intercepted in this portion.

Bore wells are normally fitted with energised pumps if they are capable of yielding relatively high and sustained discharge of the order of 10,000 litres per hour or more. One the other hand bore wells are only fitted with a hand pump if the discharge is relatively less of the order of a few thousand litres per hour. In remote rural area like the Attappady valley and Thekkumkara Panchayat where providing energised pumps to bore wells is difficult, most bore wells are only fitted with hand pumps irrespective of the yield.

Siting successful bore well locations is usually more involved and complex than siting hand dug well locations. Remote sensing techniques employing a combination of satellite images and aerial photographs can be elegantly used to identify groundwater potential zones on a regional scale. Detailed geophysical investigations using techniques like earth resistivity method can be then undertaken within the identified potential zones to site specific bore well locations. These scientific techniques were widely used in the project area with a good measure of success.

The use of bore well hand pumps as assured sources of drinking water supply was demonstrated in the project area at three places. They were located at Vengalakundu, Karyad, and Kallumkottam in The kkumkara Panchayat. The people residing in these areas were experiencing acute drinking water shortage. Other simple groundwater extraction structures like hand dug wells were also not found to be feasible in these areas. The implementation of a bore well hand pump water supply scheme will involve expenditure towards the following two main components of work:

* Construction of the bore well

* Installation of the hand pump

The cost of constructing a bore well will depend on the total depth of drilling and the length of casing pipe which has to be provided in the overburden portion. The current rate of drilling with

DTH Rig in the project area is about Rs. 150/-per metre. The casing pipe costs about Rs. 400/-per metre. The bore wells in the project area have a total drilling depth ranging between 25 and 75 metres. The depth of overburden in the project area is typically about 15 metres. Thus a bore well constructed to a total depth of about 50 metres will cost about Rs. 14,000/-.

A good quality hand pump will cost about Rs. 3,500/- A suction pipe which is usually GI pipe of 32 mm diameter will have to be lowered into the bore well upto the maximum expected depth to water level within the bore well. This depth in the project area will be typically between 20 and 30 metres. The cost of GI pipe of this length will be about Rs. 1,500 /-. A platform will have to be constructed around the hand pump. This will cost about Rs 600/-. The charges for installing the hand pump in the bore well will be about Rs. 500/-. Thus the total cost of procurement and installation of the hand pump in the bore well will be about Rs. 6,000/-.

The total cost of implementing a typical bore well hand pump water supply schemes in the project area will be therefore about Rs 30,000/-.

The three pilot projects where bore well hand pumps were developed as water sources in the project area are now benefiting more than 100 families who were previously facing acute scarcity of drinking water. There is sufficient scope to replicate similar water supply schemes in other parts of the project area and outside of it.

5 0 CONCLUSIONS

The scope of scientific development of traditional water sources for drinking water supply among weaker sections has been successfully demonstrated through the implementation of a number of pilot projects in Thekkumkara Panchayat and Attappady Valley. These pilot projects involved either renovation of existing dug-wells and pits or development of springs or drilling of borewells and fitting them with hand pumps. The cost of each pilot project in the above three categories were Rs. 3,500/-, Rs. 18,000/- and Rs. 20,000/- respectively. All the pilot projects implemented in the project area have been found to benefit more than 500 harijan and tribal families who were previously facing acute drinking water shortage. The beneficiaries could be motivated to actively participate in the implementation of all the pilot projects. The non-governmental voluntary organizations working among the beneficiaries were also actively involved in the implementation. The success of the pilot projects and their relatively low costs can to be a large extent attributed to the above two factors.

ACKNOWLEDGEMENTS

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□

Microcomputer Use in Urban Water Supply and Sanitation in India

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1. INTRODUCTION

Microcomputers have been introduced in water supply and sanitation sector over the Asian Region through the use of water supply and sewerage network design softwares provided by the World Bank. As the technical functions of water supply and sanitation sector are handled by national and provincial agencies, which generally have strong technical base, introduction of the use of microcomputer through use of network design was first attempted. The possiblity of looking into the sensitivity of design parameters, thus enabling selection of most suitable options consistent with the prevailing situation further stimulated proliferation of the use of microcomputers in the sectoral administration. Now, microcomputers are used in the countries in the Asian Region not only for network designs but also in the information management, database management, design of water works, financial analysis, project management, water utility billing, etc. Microcomputer population in the water agencies is thus steadily increasing.

2. INVESTMENT IN WATER SUPPLY, AND SANITATION-INDIA

The Government of India (GOI) places priority on the provision of water supply and sanitation. Its target is to provide water for all and sanitation to 80% of urban and 25% of rural population by 1991. By this it intends to reach 570 million people with water supply and 290 million with sanitation. Further, it intends to serve 100% of its population with both water supply and sanitation by the turn of century. This will require a cumulative estimated investment of 300 billion rupees. The cost of operation and maintenece for the assets would be 2 to 3 billio n rupees per year. For water supply construction alone, the government is spending approximately a sum equivalent of US $ 600 million annualy.

3. COMPUTERISATION IN THE WATER SUPPLY SECTOR

Tracing back to the history of advent of microcomputer culture in the sector, it may be mentioned that the Government of India was looking for use of computers in the management of rural water supply programme for quite some time. The need for electronic data processing gained more importance since 1982 when the scope of the rural water supply programme was enlarged with introduction of Twenty Point programme, under which the Government of India largely contributed to the growth of rural water supply and enforced strict monitoring of the programme in the form of watching the progress and also in clearing the schemes for implementation. The size of the programme was gigantic - there are about (600,000 villages in the country, annual investment by the Government of India alone is about) 3000 million rupees in rural water supply. It was being felt almost next to impossible to manage the database manually with the upward swing of activities in the water supply and sanitation sector. Several openings for computerisation of the database was thought of, but could not be implemented at that time chiefly, due to hardware constraints.

That was the time (1982) when the news about the microcomputer applications started pouring in and use of such a tool was being considered more suitable in view of the need for distributed data processing required at various levels. Simultaneously, use of microcomputers for efficient design of piped network of water supply distribution and sewage collection was also being considered. In fact, training couress on the use

of mainframe computers for piped network design was taken in hand under the PHE Training programme since quite a few years. This Training efforts did not show the expected results as the water agencies, in most cases, did not have any access to a mainframe computer.

However, mainframe computers were in use for design of water supply distribution network. It was severly limited to only large Municipal Corporations as the cost of using computer was beyond the affordable limit of small and medium entities. The designs used to be carried out by the Consultants on contract basis.

4. Introduction of Microcomputers in the Sector

The policy adopted by the Government brought tremendous impact in the growth of electronics and specially, the microcomputers in the country since 1985. At the same time, the GOI endorsed UNDP/ World Bank Projects on Preparation of Water Supply and Sanitation Investment Projects through which the World Bank provided the softwares developed under the United Nations Development Programme Interregional Project INT/81/047 and also provided opportunities for training engineers of various state agencies in the use of the softwares. The Ministry of Urban Development took the opportunity and launched a programme of introduction of use of Personal Computers in the sector.

First workshop titled "Use of Microcomputer for Improved Planning and Design of Water Supply Distribution Network and Sewerage" organised by the Ministry of Urban Development in close collaboration with the UNDP/World Bank Project was held in February, 1986 at Trivandrum, Kerala with 13 participants. All but one of six resource persons were expatriate.

But, right from the beginning the stand taken by the government as well as the UNDP/World Bank Project was to build up national capacity to be able to run such courses without any external resource persons. Therefore, emphasis was given to identity the potential trainees who could later handle similar workshop as trainer/resource person. Again, in view of large number of agencies active in the water supply sector, decision was taken to only cater to the needs of such agencies who are really keen on use of micros and is also ready to train middle level engineers who function as the backbone of Planning and Design Units of respective entities and who would be in a position to impart training to the youngers attached to the planning and design of networks. This snow balled the activities related to micro use.

The case studies used in the workshop were originally designed manually for a thirty-year design life. For comparision of costs, each case was first simulated with the program using the original design parameters and pipe sizes. The modifications were made in the sizes of pipe, maintaining the same design criteria for minimum pressure, peaking factor, and demand distribution in the system. The results are briefly explained.

- Cost comparisions show that the computer designed networkscould give a savings from 7% to 24% in cost, as compared to manual design.
- A better pressure distribution was attained through more efficient designs.
- Design process was very fast and enable the designer to check the design for various conditions.

5. Moving Forward with Microcomputers

The announcement of the outcome of the case studies undertaken in the workshop and the offer of 50% cash contribution by the Ministry of Urban Develoyment, GOI for purchase of hardware and software raised considerable demand for repetition of similar workshops. The Ministry also provided technical support in respect of contract finalisation, etc. to the state agencies through its technical wing (CPHEEO) Senior Managers of various state agencies were also addressed through Microcomputer Appreciation Courses coupled with regular training courses.

Such an effort resulted in wider demand from the water agencies for more workshops, and the Government of India and the UNDP/World Bank provided four repeater workshops in the following one year period. Almost all state water and sanitation agencies took up the opportunities and thus each major agency had at least two engineers trained in the use of microcomputers for planning and design of water networks and sewerage systems. They also responded positively to the offer of GOI cash contribution for buying hardware and software, and by the year (1986) end most of the major water agencies began using micros in house.

Reports from various users indicated that 10-20% savings in capital costs of water distribution networks were being achieved along with major reductions in resources and time required for the actual design procedure. It was estimated that resultant savings in construction costs would be on an average 30 million US dollars per year which is equivalent to the capital cost of providing water supply service to nearly one million people.

Subsequenty, workshops on microcomputer use in Database Management, Financial Management, Project Managemet, Management Information System were held under the joint sponsorship of GOI and the UNDP/World Bank.

6. Spin Offs

Trained manpower, availability of microcomputers and required software ushered in the computer use in the water agencies. The participants of various workshops eventually helped dissemination the concepts and techniques among their suboridinates and peers and the microcomputers found a wide acceptance. The initial workshops also identified a number of participants as trainers for future workshops. A few workshops have already been conducted by them, Refresher training course has been held to transfer latest softwares to the agencies and interaction with the users.

With more and more use of the micros, demand of application softwares for various needs were registered. Immediate demand came in the form of a Database for urban water supply and sanitation and Management Information System. The Database Management software developed in February, 1987. Development of Management Information System (MIS) was taken up in October, 1986 and released to state agencies in April, 1989 after successful operation of a Pilot MIS at Bhopal, Madhya Pradesh. As a sequel to the demand from various agencies to GOI, efforts were made to develop several other application softwares. A list of the application software developed/being developed in India is attached.

The Sector Development Team for Asia has now taken up modification and upgradation of the technical softwares. The new version of the technical software package is expected to be released in early 1991. Development of a General Financial Model suitable for Indian conditions is under discussions at present. The Ministry of Urban Development has set up an Implementation Committee to oversee the development of microcomputer based water utility billing system.

7. FUTURE TRENDS

With the state agencies being equipped with the hardware and design softwares, they are in better position to look for various options in the design practices. As mentioned in previous section, microcomputers are being used in diverse application areas. It is felt that in course of time, and various new generation softwares being availble, hardware configuration will have to be upgraded by (i) expanding Random Access Memory to 1-2 megabytes; (ii) increased hard disk capacity; (iii) addition of back up devices (iv) plotting and digitising facility (v) in some cases, where large volume of data processing will be required and due to the need of data security, etc. switching from DOS to UNIX or XENIX will have (to be considered. The power and capability of microcomputers have) given added strength to the agencies and it is strongly felt at this time that they will be used to the fullest extent for management of drinking watersupply.

REFERENCES

1. Report of the Joint UNDP/World Bank Evaluation Mission - Preparation of Water Supply and Sanitation Investment Projects, April 1987.

2. National Master plan-India, International Drinking Water Supply and Sanitation Decade 1981-90, Ministry of Works & Housing, July 1983.

3. Technical Co-operation between Developing Countries - National Decade Planning Experiences - The process of Planning and Implementation in India, August 1984.

4. Reports of Workshops on Improved Planning and Design of Water Supply Distribution and Sewerage Networks conducted by the Ministry of Urban Development, Government of India and UNDP/World Bank Project RAS/86/160

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Microcomputer Use in Urban Water Supply and Sanitation in India

LIST OF SOFTWARES

A. Software Developed

1. Urban Water Supply and Sanitation Database
   Used for creation of database for urban water supply and sanitation and management reports
2. Management Information System
   - — Planning

     A tool for planning for the future based on current information
   - — Project Monitoring

     A software for watching physical and financial progress
   - — Operation and Maintence

     Covers information on equipment, water meters and customer complaints. Facilitates monitoring response, indentification of chronic complaints, planning replacements, etc.
   - — Finance

     Provides management to bring in control over expenditure
   - — Inventory Control

     A system to follow up orders, initate orders and plan movement of items.
   - — Personnel

     Helps manpower planning and placement
3. Population Forecast
4. Design of Water Works
5. Monitoring of Externally Aided Projects
6. Monitoring of Annual and Five Year Action Plan
7. File Management
8. Water Resources Information (For state water supply agencies)
9. Management of PHE Training Programme

B. Software Development in Hand

1. Modification and Upgradation of Software for Design of Water Supply Distribution Network
2. Modification and Upgradation of Software for Design of Gravity Sewers
3. General Finance Model
4. Water Utility Billing System

"Water Hammer in Conveying Mains" Appurtenances, Methods, Concepts and Misconcepts- a review

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1. The cause

1.1 Basic Equation

In any fluid conveying system, variation in flow is associated with variation in pressure. For sudden change in flow variation, Joukowsky established the law.

$$H = \frac{-a\Delta V}{g}$$

where H = rise in pressure
a = Velocity of pressure wa ve
V = Velocity of flow
g = Gravitational constan t

-ve sign in this equation indicates rise in pressure for reduction in velocity and vice-versa. If the same is applied to instantenous closure of valve in gravity main then, the rise in pressure.

$$H = \frac{a\,V_o}{g}$$

where V_o is the velocity of constant flow which is stopped by closure of gate.

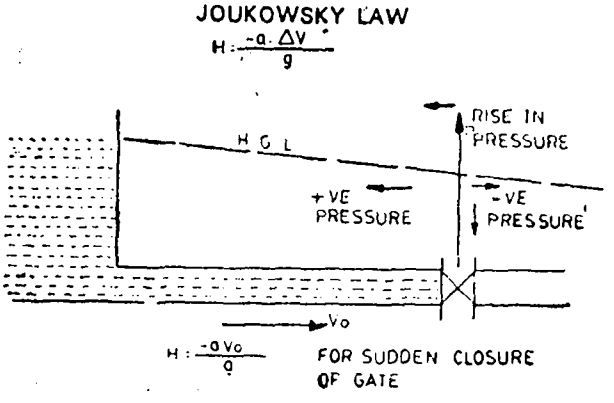
1.2 Physical interpretation

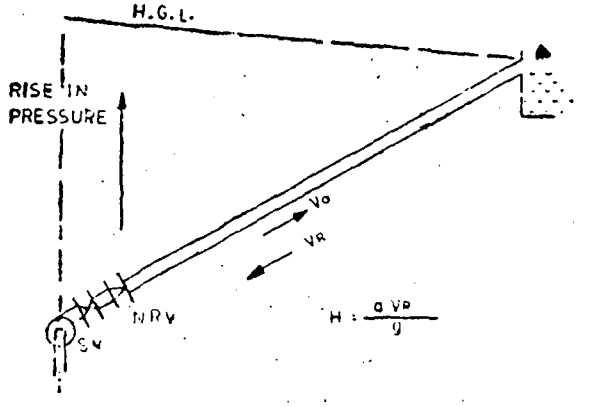
The nature of increased pressure is like a wave and travels over the entire length of the line until it reaches some constant pressure condition like an open tank or a dead end like a closed valve. Such conditions are termed as boundary conditions.

The wave dies down mainly due to intramolecular friction of fluid and pipe wall particles. Speed of pressure wave is practically equal to sound wave in the system and normally varies between 900 to 1400 m/sec.

1.3 Application to Pumping Main

Many times, Joukowsky Law is wrongly used to estimate upsurge in pumping mains where forward velocity V_o is directly used in the formula. In fact, after stoppage of pumps, the flow continues in forward direction due to momentum. After some time, the flow reverses and accelerates towards pumps and the same is stopped at Non-return valve. The velocity in reverse direction at the instant of closing of non-return valve is required to be estimated for use in the formula. (Ref. Fig. 1)





Pressure Rise Gravity vs. Pumping
Top Fig. 1 Bottom Fig. 2

1.4 Effect on Design of Pumping Mains

In some Indian standards (I. S. 458–1971) the working pressure is defined as "The actual maximum water pressure including abnormal conditions such as water hammer to which the pipe is subjected including water hammer"

The designer considers this with direct application of Joukowsky Law. A moderate velocity of 1m/sec and average pressure wave velocity as 1000 m/sec the water hammer pressure is @ 10.2 Kgf.cm2 . To this, static head is added and maximum working pressure is derived.

This process obviously leads to very high working pressure. Naturally this leads to selection of pipes of higher classification or lower flow velocities, leading to uneconomical design.

1.5 Methods of Analysis

Main problem in estimation is due to the fact that the pumping mains are normally having undulating terrain and the effect of momentum and gravity is different in different zones. On tripping of pumps this causes non uniform velocity changes depending on gradients of individual zones. These again are interdependent. Secondly, there is likelihood of separation of water column at different points and effect of rejoinder of separated columns is also required to be taken into account.

Upto single separation at pump house, graphical method (Kepheart and Devis) gives reasonably good results. For schemes with undulating terrain, step by step analysis known as method of characteristics is required. Due to number of repetitive calculations, use of computer becomes inevitable.

1.6 Modification required in Joukowsky Law for estimation & Water Hammer pressures.

There is no single formula available (which can be applied universally to any pumping main) giving either the maximum upsurge or the value of the reversed velocity at the instant of closure of non-return valve or meeting the already closed non-return valve.

In case of model pumping main as shown in Fig. 3, the velocity of reversal at high point dashing against the stationary column L1 is estimated by the formula.

$$V_R = \left[\frac{Z_2 V_o^2}{F_2} \times \left(1 - e^{-(B F_1 / L_1)} \right) \right]^{\frac{1}{2}}$$

where

$$B = \frac{L_2}{F_2} \times \ln \left(1 + \frac{F_2}{Z_2} \right) - \frac{L}{F} \times \ln \left(1 + \frac{F_1}{Z_1} \right)$$

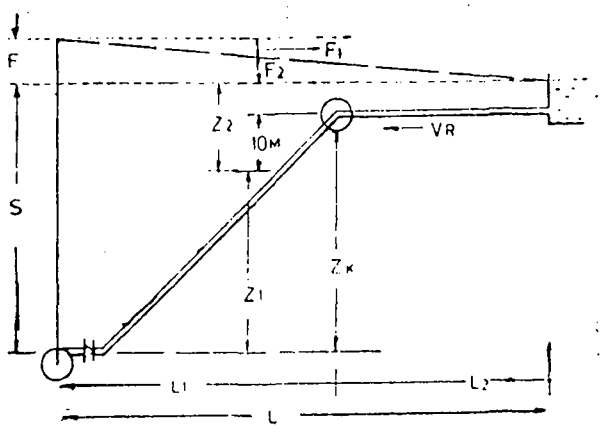


Fig. 3

Another derivation of above formula is that if B is-ve, separation does not occur at that point.

The same formula can be applied to a steadily rising main where $L_1 = 0$ and $L = L_2$

The Joukowsky Law can be further modified and applied to a rising main of constantly rising uniform gradient. The Joukowsky Law takes the form.

$$H = \frac{a V_r}{g} = \frac{a V_o}{g} \sqrt{\frac{S}{S + F}}$$

Results with above formula were tallied with analysis carried out by step by step method (method of characteristics) on computer (The method which is universally applied for analysis of any type of scheme) and were found to be in reasonable agreement for engineering application.

It was further tried for schemes with pipe lines convex downwards. Surprisingly the results were also found in agreement with modified Joukowsky Law.

However the results differ considerably if there are more than one separations in line and it becomes necessary to analyse the system by method of characteristics. This should be treated as limitation for application for modified Joukowsky Law.

2. Appurtenances

In normal practice, non return valve and air valves form an integral part of the system. Non return valves are installed on delivery side of

pumps. Practice of installing in line non return valves is now discontinued in majority of the schemes.

2.1 Air Valves

Larger orifice of Kinetic or double air valves is meant for breathing in or out large quantities of air during charging or discharging of pipe line. These valves can also breathe in/out air during tripping, in case, pressure at that point reaches vapour pressure or separation of column takes place. The air can be discharged/charged through air valves with a velocity about 50 to 75 m/sec.

2.1.1 Capacity of Air Valves

The capacity of Air valve should be at least 1.5 times the maximum rate of flow of water during charging/discharging.

A simple equation can be formed in S.I. units to determine diameter of Air Valve.

Dia of Air Valve = D Metre

Discharging/charging rate = Q M^3/ Sec. then $D = K\sqrt{Q}$

where K is between 0.13 to 0.195.

2.1.2 Utility of Air Valves

Air Valves do not contribute in reducing +ve surges even though these can reduce -ve surges (pressures below atmospheric) when separation of column tends to occur.

The Kinetic principle, in case of double air valves (smaller orifice) is meant to remove accumulated air during working (Ref. Fig. 4). These are required at all humps to remove accumulated air during working. Many times, this accumulated air, if not removed, forms a constriction in the pipe line (Ref. Fig. 5) increasing flow velocity in the constricted region. This air is carried by water column as large bubbles when skin friction overcomes buoyancy. During such removal the flow velocity in the constriction suddenly drops and then comes to normal. This is associated with mometary rise in pressure causing damages to pipe line in the vicinity. At such location when an air valve is installed, the problem many times, is fully solved. (Also thanks to leaky air valves).

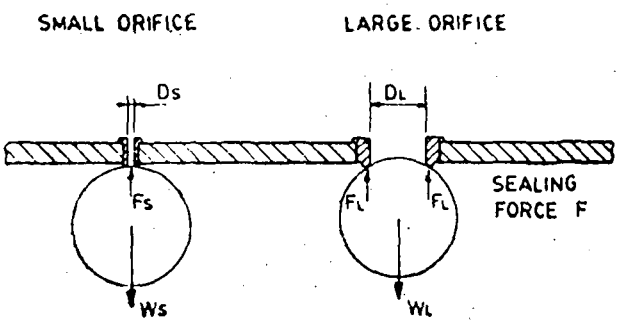


Fig. 4

For A Kinetic (Double) Air Valve of 3" (80mm)N.B. Working pressure of 5 Kgf/cm2

D_1 = 6 Cm (say) & D_s = 0.3 Cm

$$F_1 = \frac{\pi D_1^2}{4} \times 5 = 141 \text{ Kg.} >> WL$$

$$F_s = \frac{\pi D_s^2}{4} \times 5 = 0.35 \text{ Kg,} < WS.$$

The float ball in small orifice chamber falls down to enable accumulated air release.

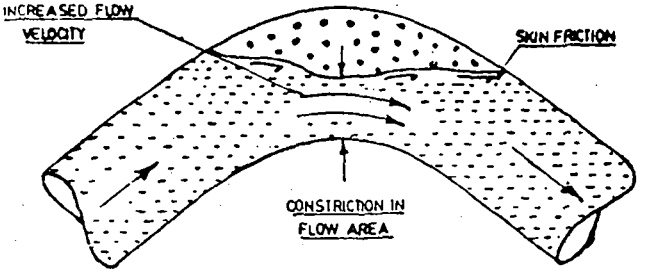


Fig. 5

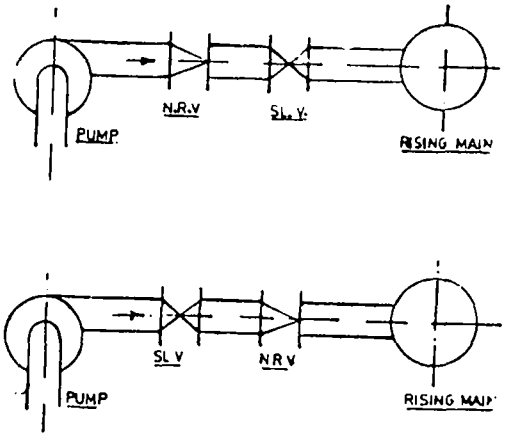
2.2 Non Return Valves

Non return valves are normally installed on delivery side of pumps. This is meant to protect the pumping machinery from surge pressures. It is observed that the non return valve is many times fixed prior to isolation (sluice/ BF) valve giving a reason that in case of breakages of non-return valve flap, repairs can be attended.

2.2.1 Non Return Valves Positioning

In author's opinion, the positioning of non-return valve should be beyond isolation valve

(Ref. Fig. 6). The sluice gate is not designed for operating under pressure from one side (Requiring much higher torque experienced by operators). The non return valve is designed to take pressure from one side.



Top: Present way of Installation
Bottom: Preferred way of Installation
Fig. 6

Another advantage in such positioning is that the non return valve can be placed outside the pump house and proper anchorage can be provided for non return valve. As in case of Sluice Valve, similar force is also experienced by non return valve which is required to be borne by thrust block. In present way of installation, the pump foundation is subjected to this force causing mis-alignment etc. In proposed arrangement, spacing can accommodate proper thrust blocks.

The fear of breaking of non-return valve flaps is due to the fact that on tripping, the non-return valve closes with a bang. Closure with a bang is mainly due to delayed closure compared to reversal of flow. (Ref. Fig. 7). In author's opinion slow closing non-return valves add to the problem. In recent research works carried out at British Hydrodynamics Research Association in U. K. and Delft Hydraulics Laboratory in Netherlands on surges due to closing time of non return valves have proved that faster closure is always helpful in reducing surges. (Ref. 1 & 2). In some field trials by the author, reducing the closure time of non-return valve has stopped banging noise and reduced the surge effects. All over the world the trend now, is towards reducing closing time of non-return valves.

2 3 Pressure Relief Valves

The valve opening can occur only when higher pressure is developed in main, due to gland friction, momentum of moving parts, resilience of heavy springs, these valves serve practically no purpose of reducing surges in pumping mains.

2.4 Values of thrusts on Bends (Ref. Table 1)

The design of thrust blocks should be carried out at the maximum surge pressure expected at that point and not at the working pressure at that point. A reference table is given for the thrust values. (Ref. J. W. Pednekar & L. G. Dhaygude I. W. W. A. Manual for design of large diameter steel pipes).

TABLE 1

Thrust values for bends for one KGF/CM² Internal Pressure

DIA MM ANGLE→	VALUES OF F IN KGS 15	22.5	30	45	67.5	90	180
100	20.515	30.66	40.68	60.143	87.31	111.11	157.000
200	82.059	122.65	162.71	240.572	349.23	444.44	627.999
300	184.632	275.96	366.10	541.288	785.77	999.99	1412.998
400	328.235	490.59	650.84	962.289	1396.93	1777.76	2511.996
500	512.868	766.55	1016.94	1503.577	2182.70	2777.76	3924.995
600	738.530	1103.83	1464.40	2165.151	3143.09	3999.97	5651.992
700	1005.221	1502.44	1993.20	2947.011	4278.09	5444.40	7692.989
800	1312.942	1962.37	2603.37	3849.157	5587.71	7111.06	10047.990
900	1661.692	2483.62	3294.89	4871.589	7071.94	8999.93	12716.980
1000	2051.471	3066.20	4067.77	6014.308	8730.79	11111.03	15699.980

NOTE: For estimating thrust on any bend, the above values should be multiplied by maximum working pressure in Kg/Cm² at the location.

3. Types of surges

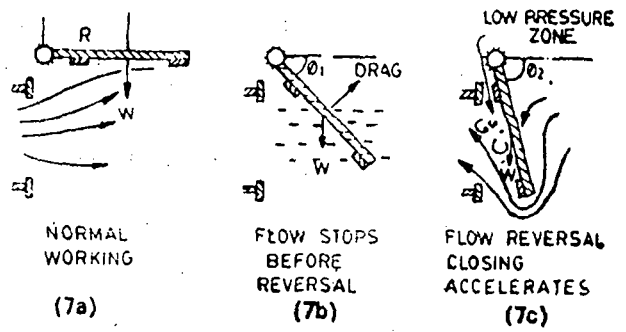
Common causes of surges can be divided into 4 catagories.

(a) Surges due to starting of pumps.
(b) Surges due to tripping of pumps.
(c) Operation of valves in gravity mains.
(d) Filling of Empty pipe lines.

Other causes like cavitating pumps, throttled valves, mechanical vibrations of components, resonance, gate operation of canals are rare occasions and hence are not discussed here.

3.1 Surges due to starting of pumps

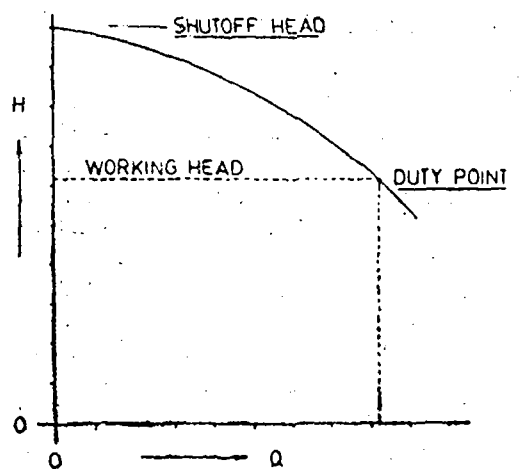
The pump characteristic curve is represented in Fig. 8. If the pumps are started with gate valve open, then the column is accelerated in a very short time during which the pump works under shut off head and the higher pressure wave is transmitted to the line.



Closing Force
(1) W×R
(2) W×R Sin$\varnothing_1$ − Drag of water
(3) W×R Sin$\varnothing_2$ +(Pressure Diff. × Area)

Closing of Non Return Valve after Tripping of Pumps

Fig. 7.



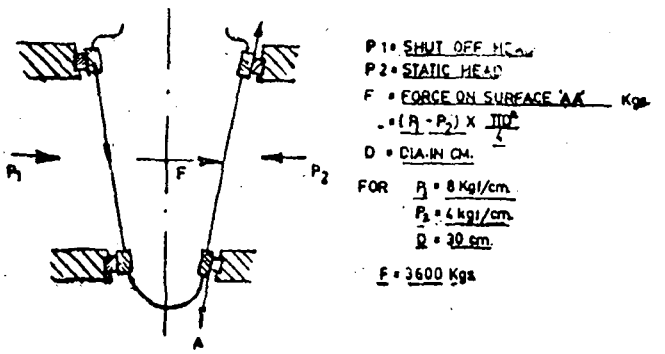
Typical Pump Characteristic Curve

Fig. 8

In case of partially open gate valve (normally 1 or 2 turns) a similar condition occurs and + ve pressure wave is transmitted to the line.

In case of fully closed valve the pump works at shut off head and with slight opening of gate-valve the wave is transmitted to the line.

In last two cases, very high torque is required on valve spindle, because the gate rubs with very heavy force due to pressure difference across gate. (Ref. Fig. 9). Due to this heavy torque, the operators tend to start pumps with gate valves open. This force also causes damage to valve seats.

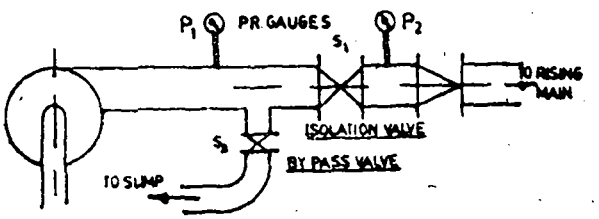


Force on Sluice Gate

Fig. 9.

3.1.1 Solution to avoid starting surges

To avoid these problems, a simple method is given in Fig. 10. With this method, the starting surges in line can be eliminated. This also increases valve life considerably. Author has successfully tried this method in many cases with different lengths, head and diameters.



By-pass for control of starting surges

(1) Close 'S'$_1$ & Open 'S'$_2$
(2) Start Pump
(3) Close 'S'$_2$ till P1 = P2
(4) Open S_1 thru 1 or 2 Turns
(5) Close S_2 slightly
(6) Continue the process keeping 'P'$_1$ slightly above 'P$_2$ till 'S$_1$ is fully open and 'S'$_2$ is fully closed

Fig. 10.

3.2 Surges due to tripping of pumps

This is a subject of very wide interest, as majority of water supply engineers face this problem. The type and design of control system is governed mainly by the constraint like site conditions, type of main, the limit of control and economics.

Air Vessels and combination of Zero Velocity Valves and Air Cushion Valves are widely used covering maximum range of types of systems.

In case of network of bore wells, or large number of pumps operating in parallel, tripping of one (or more) of the pumps can cause severe surge pressures causing damages mainly to non-return valve and gate valves on pumps. Closing time of non- return valve in such cases becomes a prime factor deciding the limit of upsurge. In such cases the situation is required to be studied in detail before deciding the control system.

3 3 Surges due to valve stroking

This condition mainly prevails in gravity mains or hydro electric stations (for analysis, both are practically same). Valve closure time of $\frac{5L}{a}$ normally reduces surges below safe limit. A further betterment in results can be achieved by closing valve upto 80% at a faster rate (say 3L/a) and remaining 20% much slower (say 2L/a).

For hydro electric stations, surge wells are normally used as the closure of gate is very fast depending on variation of electrical load.

3.4 Filling of empty pipe lines

This problem becomes more severe in case of undulating lines and flatter terrain. During process of charging, some pockets get filled earlier and when moving water column reaches a stationary column, then, surges similar to starting surges are observed. Air locking also creates problems at humps. To avoid these problems, all air and scour valves are kept open. (Removing ball of air valve). The scour valves are closed when water column reaches the valve. When water reaches air valve the gate valve below the same is closed (kept bleeding) and ball is replaced after sometime. During entire operation of filling, the pumps are run under throttled condition.

4. Different Types of Surge Control System

It is not the intention of this note to go into details of different types of surge control equipment. However these are listed below. Interested readers are requested to go through the paper of the author published in October 1987 issue of the I. W. W. A. Journal. (Ref. 6)

(a) Increase of flywheel effect.

(b) One way surge tanks.

(c) Air Vessels
also named as

(i) Surge Arrestor

(ii) Surge Vessels

(iii) Two way surge tanks

(iv) Air chambers.

(d) Combination of Zero Velocity Valves & Air Cushion Valves. Valves very similar in shape and design of Zero Velocity Valves are made in Germany by Mansmann — Demag.

(e) Quick opening — slow closing bleeder valves.

(f) Surge wells or surge towers (Mainly for gravity mains).

(g) Pressure relief valves (Mainly for gravity mains associated with closure of valves).

(h) Slowing of valve closure timing (In case of gravity main only).

The author would like to express his gratitude to following persons for discussion on various aspects of water supply engineering problems.

CONCLUSIONS:

(1) Joukowsky Law cannot be used directly for any pumping mains.

(2) For typical applications, modified Joukowsky Law can be used for estimation of maximum upsurge.

(3) Definition of "Working Pressure" given in I.S. also needs to be modified. In fact a common terminology must be properly defined applicable to All Standards/Hand books.

(4) Selection of Kinetic Air Valves alongwith sizes should be done with proper understanding of function.

(5) Modification in way of installation of Sluice and Non-return valves on delivery side of pumps is suggested.

(6) Solution for avoiding starting surges is given.

(7) Some solutions to typical problems is given.

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(2) Dr. D. M. Mohan,

Suprintending Engineer, Hyderabad Metro W/S Board.

References :

1. Dynamic response of check valves, Dr. A. R. - D. Thorley, 4th International Conference on pressure surges Bath. U. K. 1983.
2. Investigation into dynamic behaviour of nozzle check valves, Report on measurements No. M 1893-1983 Delft Hydraulics Laboratory The Netherlands.
3. Draft report on transients with water column separation Vol. 1, 2, 3, International Association for Hydraulic Research Draft Report 1987.
4. G. H. Pearson, Applications of Valves and fittings (Pitman) 1968.
5. Ronald Bartlett and William Madill, Hydraulics for Public Health Engineers (Applied Science) -1982.
6. Pressure Surges in Pumping Mains, V.P. Kulkarni, I. W. W. A. Journal October 1987.

HOW THE CONTINENTS DERIVED THEIR NAMES

The Greeks took the names "Europe" and "Asia" from the Phoenicians, who got them from Assyrians. "Ereb" meant the land of setting sun or of darkness and "Asu" the land of the rising sun. Africa was the name of the neighbourhood of "Carthge" an ancient city, on the Gulf of Tunis. It is derived from a Berber tribe-the Afarik, whose descendents are known today as the "Aouraghen". America was named after a navigator from Floerence in Italy, Amerigo Vespucci, who claimed to have taken part in a number of voyages across the Atlantic ocean from 1497 onwards. Australia is derived from "Terra Australis" meaning southern land, a name given to some imaginary land in that area about which people used to talk long before explorers from Europe landed there.

Financing and Management of Water Supply Schemes

(B. F. H. R. BIJLI
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This topic is very relevant today, particularly after the end of the International Water Supply and Sanitation Decade. The views expressed here are the author's personal views on the subject arising out of the existing situation. This topic can be divided as follows.

1. Financing new and augmentation of the existing water supply schemes.
2. Financing the maintenance and continuous renovation of the existing water supply schemes.
3. Managing the implementation of new and augmentation projects and
4. Managing the operation, maintenance and consumer service of the existing water supply schemes and revenue collection.

Generally the topic reduces to management of finance and management of works.

Water is a basic need. Thus it is one of the unavoidable essentials of life. It is but a fact that nature provides the water, but on account of present day concepts it should be of certain quality and so now drinking water has come to mean to be that water which is supplied through the pipes. In our state 70% of the rural population and 20% of the urban population are yet to be supplied with piped water supply. We must understand that our population lives mostly in rural areas and as such on an average this works out to around 65% of the population of the State not being supplied with drinking water through pipes. How do they survive then? Obviously by drinking water from the domestic water wells and to a much lesser extent from the rivers, streams, tanks etc. It is estimated that on an average 200 water wells are available for every 500 families. Thus it is a Herculean task to achieve 100% drinking water supply proposition if we have to resort to only piped water supply. Supplying water through dug wells should also form part of the process. This will result in enormous financial savings also. When we consider this as a vital part of the drinking water supply programme it becomes imperative to take keen interest in the upkeep of the ground water. This is not to minimise the importance of the piped water supply systems. Piped water systems are very essential for the urban areas, areas where sweet water is not available (like islands surrounded by brackish water or lands very close to sea or back waters) or where the ground water contains unacceptable dissolved salts. Thus it is obvious that to provide 100% drinking water supply to our citizens we have to explore the traditional methods as well as modern methods.

Whether it is traditional or modern water supply system finance is a must. The financing channels available are as follows.

1. Allocations from the State Government.
2. Allocations from the Central Government.
3. Institutional financing like L. I. C., HUDCO etc.
4. Loan from foreign lending agencies like World Bank etc.
5. Bilateral aid from Foreign Countries like Netherlands, Denmark, etc.
6. Water supply schemes by private entrepreneurs or on Co-operative basis
7. Drinking water tariff.

Allocations under the yearly State budget has been the main source of funding for the water supply and sewerage works for a long time and continues to be so despite the formation of the autonomous Water Authorities or Boards. Due to socio-political reasons proper water tariff harnessing has not been able to be accomplished. People do not realise, politicians might be realising but do not subscribe to that, that one way or the other it is the people who pay either thru' taxation on other accounts or direct payment as water tariff. Nevertheless as things stand today it is the budget provision, directly to implement the scheme, or supplement the maintenance of a running scheme or as counterpart funding for obtaining the reimbursement from agencies like World Bank, that helps in financing any water supply scheme.

Central Government has fund allocations for specific schemes like A. R. P. etc which are to conform certain norms imposed by them. Situations vary from State to State and such norms, sometimes are difficult to cope to. Nevertheless, such funding is available which is made full use of as far as possible.

Under institutional financing, pioneer institution so far has been the Life Insurance Corporation of India. Recently HUDCO has opened a new chapter in their activities by coming forward to finance water supply schemes. It is desirable that financing agencies such as Unit Trust of India and Nationalised Banks can come forward to finance water supply schemes. Generally the funding agencies, despite all being in Government sector, are reluctant to lend to the Water Supply and Sewerage systems implementing agencies which are also in Government sector because of the uncertainties of the proper revenue collection procedures in them and thus are afraid of their money not being paid back.

There has been generous grants/aids given by the bilateral agencies for implementing water supply schemes. So far as no strings are attached in such aids, they should be most welcome. Generally the funding countries are developed and their men desire the implementation done in the same swiftness and efficiency which is a little difficult to obtain in this country due to the prevalent procedures, practices and conditions. All the same the achievement due to this funding is significant.

World Bank has also come forward to help the implementation of water supply projects as it does so many other projects. The World Bank funding have conditions sometimes beyond the implementing capabilities of loan recipient agencies. All the same it is a fact that several innovative ideas have been introduced due to this assistance.

In agricultural field, banks such as NABARD as also various nationalised banks adopt certain farms, dairy and poultry projects, plantations etc and bestow special attention in their bringing up. They can think in terms of helping water supply schemes also in a similar way.

Another innovative idea would be to go private, encouraging private entrepreneurs to come into the field on business proposition, as that is exactly what the World Bank loan will eventually lead us to. India is a wealthy country, contrary to what the western countries make we to believe, wealthy in talent and resources. Generally these lie hidden and sometimes in pockets. India which had no debts on the day of independence now has on its head about a million million rupees debt. Lots of highly qualified, talented people are returning from Gulf not knowing what to do. Besides them we have scores of talented people already here vying for opportunities. Why not utilise them and also the wealth hidden or scattered? If we cannot accept privately done and maintained water supply schemes we can modify to bring them under co-operative sector.

The best and the all participating solution for generating funds is water tariff. This can be done in a direct way and in an indirect way. The State and the Central Governments allocate funds for implementation of water supply schemes. Also when departments avail the loan facility from various institutions it is the State Governments that guarantees the loan repayment, which again is under budget allocation. The State and the Central Governments are tax imposing and collecting authorities. It is suggested that if they can introduce a specific element in their taxation proposals on a percentage basis like 1% additional tax on the existing sales tax rates on goods, similarly on income tax they will fetch enormous amounts. The Government of India can apportion the amount thus collected to various States and the States can use the amount collected by them along with the amount given by the Government of India for implementing water supply and sewerage schemes. This does not require any additional tax collecting machinery and the water supply and sewerage facilities being basic needs

would look given to the people free, though to fact they pay for it. Also in the Railway and the bus travel tickets tariff a small but similar charge could be introduced, which again would fetch good money. It might not be out of place here to mention that the Social Security system of the United Kingdom is run on a similar basis.

Water tariff, normally, is imposed on service connections. I would suggest the following in respect of the same. Here I have followed Trivandrum water supply scheme for an example on a general basis.

Impose a service connection facility charge of Rs. 10 per connection. This figure should be at a base year say 1991 April-1992 March 31. There shall be an incremental increase of Re. 1 per every year. In such a case the service facility charge will be Rs. 20 in 2001-2002. This will take care of inflation to a substantial extent. It will be seen that the escalation though starts at 10% progressively reduces in the percentage. Apart from this water supplied shall be charged at a certain rate per Kilolitre.

$$\text{Charge per kilolitre} = \frac{\text{Operation \& maintenance cost per year}}{\text{Kilolitres water supplied per year}}$$

Operation & maintenance cost = Rs. 24 millions

Water supplied = 109 mld × 365 days × 70%

(30% leakage in system is assumed)

= 27849.50 ml

$$\text{Charge} = \frac{24 \times 10^6 \times 10^3 \times 10^2}{27849.50 \times 10^6}$$

say 1.00 Rupee per Kilolitre

The water charges may be kept at a minimum of Rs 10 upto a consumption of 10 Kilolitres and charged at 1 00 Rupee per Kilolitre upto 50 Kilolitres and over and above that at Rs. 1.50 per Kilolitre. For non-domestic connections double the rates may be charged. For industries water facility connection charge of Rs. 25 and a rate of Rs. 3 per Kilolitre may be effected. It is also seen that the bulk consumers though a few in numbers, contribute the major income. As the water meters are liable to qe affected by wear and tear, it is desirable to fix an average consumption figure in an appropriate way for the domestic as well as for the industrial consumer and realise that charge instead of realising the minimum charge.

As we have generally considered Trivandrum water supply scheme for the calculation of tariff purposes let us see the income generated.

Number of consumers = 800000

Assume all are domestic

Water service facility charge at the base year = Rs. 800000 × 10 × 12

= Rs. 9,600,000

Minimum water charge = Rs. 800000 × 10 × 12

= Rs. 9,600,000

Minimum assured income = Rs. 19,200,000

Thus it can be seen that 80% of the operation and maintenance expenditure is assuredly realised. On proper reading the consumer meters domestic, non-domestic and industrial it should not be a problem to harness the whole O & M expenditure.

In municipal corporations, municipalities, panchayaths, where standposts are provided, such a facility may be charged to the concerned local body on the basis of the consumers catered by such standposts. Here the water service facility charges may be reduced. An example is worked out below.

No. of standpost provided say 60

Average No. of houses catered by each standpost, say, 30

Water service facility charge, say, Rs. 2.50 per household

Water charges @ 12. 5 paise/Kilolitre for an average 2 Kilolitres consumption (though water is supposed to be supplied at 70 1pcd) per household

$$= \frac{12.5 \times 2 \times 30}{100} = \text{Rs. } 7.50$$

So charge for one stand post = 30 × (7.50 + 2.50)

= Rs. 3000/month

So for 60 stand posts income generated for 12 months = Rs. 60 × 3000 × 12

= Rs. 216,000. say, Rs. 0.2 million

Thus we can see that an assured income can be generated from public standposts also. For house service connection water charges can be worked out in a similar way as explained for that of Trivandrum water supply scheme.

Alternatively we can install bulk meters and assess the consumption of the municipality or panchayath and charge them. But that would be difficult when all the water supply systems would be taken over by the Authority and the standposts are provided at the instance of the localbodies. It would be relevant here to remember that for providing electric light posts the local bodies pay a regular fee to the Electricity board. Also whenever water meters cannot be used suitable alternative tariff system can be worked out for both house-service connection as well as for the standposts.

Here I would like to point out that in such income generating propositions, the private entrepreneurs or co-operative enterprises can enter the field of implementing water apex bodies to fix the water rates and exercise the final control of okaying the projects for their suitability and also okaying of their implementation and commissioning. There shall be a percentage fee set apart on the revenue collected to the water authorities as royalty. If water supply schemes can be implemented with total private finance and personnel that will definitely give a great spurt in the job generating region and will be a great leap forward in attaining the goal of cent per cent provision of drinking water supply to the state population.

Now coming to the Management side of the Water Supply Authorities I would like to look at it taking Kerala Water Authority as a random sample. Generally we can identify the following activities in a public utility engineering organization. Here I wish to emphasise that in an engineering organization the rest of the staff such as the administrative or accounts play the role of supporting the engineering activity and the engineers' affairs so that they can concentrate fully in engineering, and not vice-versa. When things tend to happen the other way about, it is a pointer that engineering activities and the role played by engineers is not in order. The activities can be enumerated as shown below.

1. Investigation, Planning, and Design.
2. Stores Procurement, Storage and Supply.
3. Construction of Water Supply and Sewerage Projects.
4. Operation and Maintenance.
5. Research and Development and Training.
6. General Planning (Budget preparation), Services, Co-ordinating and as the chief technical officer of Managing Director's office.
7. Finance Manager and Chief Accounts Officer.
8. Secretary, Water Authority/Board.
9. Managing Director.
10. Board comprising of its members and Chairperson.

Items 1 to 5 shall be under independent Chief Engineers. Items 6 to 9 will be working in the Head Quarters office. Item 10 will be the members of the Board exercising the governmental powers within the limits prescribed by the relevant Act, headed by a Chairperson. Members will be official and non-official as prescribed under relevant Act.

At present the projects are prepared like fast foods and instant drinks, shallow, lacking in depth and analysis. They can better be called loan documents rather than engineering projects. This situation shall be changed. The I. P. D. wing shall have the responsibility of preparing the projects and accountability of the projects thus prepared. The Chief Engineer shall have proper organizational support, vehicles, equipment to carry out his job. Any deviation from the designed project during execution shall have to be authorised by the Chief Engineer (I. P. D.). All the designs shall be done in detail in the proper shape and norms for lucid execution.

Chief Engineer (Stores Procurement, Storage and Supply) shall be responsible for all the major procurement and supply. All the requirements for the succeeding year shall be assessed by October every year. tenders invited by November and rate contracts finalised and settled by January and February and the materials shall be available as per requirement from time to time from 1'st of April. Repeated tender calls for same item shall be avoided. Known, regular, and essential items

shall be especially taken care of. The Chief Engineer shall be in charge of main/central stores and regional stores which shall be built up and maintained in a scientific way. The Chief Engineer (Stores) will be responsible for all the stores and any delay in the project on account of lack of stores will be attributed to him. He shall have proper organizational support for exercising his duties.

Chief Engineer (Construction or Projects) shall be in charge of the construction of all projects. His job comes after the preparation of projects and financial allocation. Tendering the project components, awarding them, supervising the construction of the works and on eventual completion handing them over to O & M unit are his responsibilities. When the projects are numerous and/or enormous, it would be desirable to have more than one Chief Engineer. He should have proper supporting staff as per norms.

Chief Engineer (Operation and Maintenance) shall be in charge of the operation and maintenance of all constructed schemes, service connections and revenue collection and shall also identify and notify the requirement of augmenting an existing scheme or formulating a new scheme to cover new areas. Chief Engineer (O & M) shall have as usual requisite staff support. As the completed projects grow in number it would be desirable to have more than one Chief Engineer for O & M.

It is very desirable to have an independent wing for the monitoring of quality of the drinking water supplied, especially with the consumers health point of view, to have and take care of a network of laboratories and to have and take care of a Training Institute for the upkeep and healthy development of the knowledge and know-how of the Authority staff. This wing shall be under a Chief Engineer for proper working. This shall be independent of the other wings but shall do co-ordinating and policing job. The Chief Engineer shall have good staff support.

The Head Quarters, which will have Chief Engineer (General), Finance Manager, Secretary and the Managing Director, will exercise over-all control and authority for supervising and co-ordinating all the activities of the authority.

Generally the officers shall be allowed to exercise their respective powers. These powers shall not be interfered with by the superior officers unless on misuse on an appellate position. Also if the officers do not exercise their respective powers and carry out the work in an efficient manner, appropriate action shall be taken on them.

A chunk of responsibility vests with the engineers and quite a bit of time is spent by them in carrying out administrative, accounts and payment works. It would be a good idea to segregate the work. But this is a debatable proposition.

All recuitments shall be made every year for all the categories for which direct recruitment is done for reasonably assessed vacancies expected to arise during the year. These recruitment lists shall lapse at the end of every year and a fresh list shall be ready at that time. This will ensure filling in the arising vacancies with regular hands and thus ensuring authority in the works carried out by the department.

It is generally very desirable to review the whole working of the department once in atleast every five years and make necessary reforms. □

MULTIPLICATION OF WANTS

If we examine the food habits of older days, we will find that irrespective of Social differences most people were satisfied with food grains available in their locality. Today everybody wants specific food grains. Disappearance of simple habits besides loading the family budget has also widened the gulf between sections of society, resulting in ill-feeling and bitterness. Because the people have changed their outlook and also multiplied their wants, the Government too does not hesitate to borrow and plan for raising the so called standard of living in the country. Where are we going to end this multiplication. ?

Can You Manage?

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INTRODUCTION

Young Engineers in the course of their work have to take up the role of "Managers", often thrust into their new duty without any prior education or training for such a function. In Engineering, specialists deal with Civil, Mechanical, Electrical, Electronics, etc; that is to say, in physical man made things. In Management, the specialists are Accountants, Negotiators, Psychologists, etc; dealing with Social Aspects. And for an Engineer to become a successful Manager, he must have an understanding of management aspects and how it is accomplished.

Before the Engineer takes on the management role, let us have a look at some of the reasons for failure of an Engineer to become a successful Manager.

As an Engineer, he is pre-occupied with technological performances and time and again fails to bestow due care upon the human aspects. This, along with the traditional engineering feature of supervisory nature tends to hold back the Engineer from the liberal thoughts and vision often required of Managers.

An Engineer who is a technical trouble shooter in achieving technical excellence and perfectionism always withhold in making decisions for want of more information and evidence, when, in a managerial role, they should take a risk and take fast decisions. Engineers often find it difficult to adapt to this new situation.

Engineers with their technical knowledge and skill can become good Managers, but that is not all that is required. They must have adequate knowledge of contracts, economics, politics, psychology and labour relations, have some skill in production, marketing and financial analysis and over and above these, have knowledge in management activities such as forecasting, planning and directing Moreover, in managerial role, the Engineer will be called upon to perform long hours of work which can induce physical and mental strain.

A wide knowledge in different topics such as technical, business, politics, management, etc; acquired from magazines, journals and newspapers is also needed for the Engineer to master the management qualities. Many Engineer fail to take up the challenge and will eventually be a failure in "Management."

Then how can an Engineer become a successful and effective "Manager"? Firstly, he should be optimistic. He should not consider Management as a profession, but as an art and a science which he can master and the following will give the Engineer, an introduction to Management.

1. MANAGING YOURSELF

(A) KNOW YOURSELF

The first and foremost in effective management is managing yourself. You should know your strengths as well as your weaknesses. Once knowing your strength, you can identify the fields in which you can have the best contribution and plan to build on them. By identifying your weaknesses, you will be able to change your working methods and/or engage others to help you and plan to protect you from these weaknesses

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The manager needs both physical and mental stamina to tide over the fatigues caused through worry, frustration and long hours of work and learn to remain effective and in control during the strain periods while making difficult decisions.

(B) BE EFFECTIVE

As a manager, you should be effective by doing the right things at the right time at the right cost with the right result at the end. For this you should know who your boss is, and what all your responsibilities are, your objectives and priorities, what decisions you are entitled to take and what matters need to be referred to your boss and what reports required to be submitted with regard to progress and achievements.

In addition to your managerial works, you will be having other workload, as well. Doing other works should not divert you from managing properly. Also, shed away the concept of "doing it (everything) Yourself". Note that higher your level is, the more you should spend your time in Management. Choose the right balance between "doing it" and Management.

In addition to these, as an effective manager, you should encourage your staff to meet your required objectives and achieve higher job performance, provide enough facilities and opportunities to develop their skills and reward them on merit.

While managing works, you should effectively analyse the problems and find solutions, develop work plans, arrange the works and monitor the work of individuals and team, provide necessary finance and support to do good work and finally achieve the objectives through others at the same time "retaining personal accountability". The usual habit of taking personal credit in case of achievement and blaming your staff in case of failure should be avoided.

Evaluate your own performance periodically. Also, from time to time, try to get feed back on what you have done These will give you an idea of how things have gone. Correct it, if you have erred, strengthen it, if you are on the right track.

(C) BE EFFICIENT

As a manager, you have to plan your own work in an organised way. Lack of organisation will result in not having time for anything. Make good use of your time, and make time for works which you must do to achieve your objectives and do it today,the things that can be done today, do not postpone it. Donot waste your time and plan your time and include in your plan of work time, time to think about your next plan of work.

Managing paper work efficiently is also very important which involves both reading and writing. Sort out and take action in the order of Urgent Action, Non-Urgent Action and Reading.

As a manager, you will have plenty of things to do and it will be helpful if you write down the things you have to do as they come up Use separate files for keeping posted, agenda details, items for monthly meetings, etc.

Delegation is another activity in management, in which you let others do some of the work on behalf of you while you retain accountability. This will facilitate you to have more time to do your job and manage efficiently and to give an opportunity and training to other staff. However, delegation should not be taken as an opportunity to pass on all difficult or tedious work.

An efficient manager is one who gets things done and you should have clear determination to do it. Sometimes you may be told "Sir, we always do it this way" or "Sir, we have never done it like this before", which statements clearly show a fixed course difficult to depart from This should be avoided. As technology advances, more and more new products and new methods are introduced which incorporates easy operations and economic installations. A good manager should be conversent with these technological developments and should incorporate them wherever appropriate.

2. MANAGING OTHERS

Managing others is a very big challenge. your aim must be to achive results through positive management. Work hard yourself, if you want your staff to work hard. Set the standards for your staff by producing high quality work yourself. Be cheerful and optimistic and show enthusiasm and energy. Keep yourself calm in a crisis. This will keep others cool and will enable you to manage things more effectively.

Do not put yourself in a position where you cannot raise issues with your staff because of your own doings. As you know, it will be very difficult to take action against late-comers if you yourself is coming late.

As a manager, it is highly essential that you are trusted and respected by your staff and you wust be prepared to fight for your staff.

Do not hesitate in asking for assistance and advice from others and admit your mistakes rather than looking for excuses or someone to blame Always right the wrong and avoid repetition of mistakes.

As a manager, you have a responsibility to look after your staff and develop a real interest in each person. Do not forget faces and names Always think twice before you loose your temper or say something which you cannot take back.

You should recognise good results and achievements. Always thank your staff for their efforts.

In addition to all these, as a good manager in achieving results, you should manage the performance of your staff. Set out objectives for each individual, monitor and review the performance against the objectives (performance appraisal) and provide the necessary direction and support to achieve these objectives while at the same time, giving necessary encouragements to improve in their performance Poor performance by individuals should not be tolerated, but at the same time, talk to them and try to help them as a means of solving this. Even then, if things do not go in the right direction, consider change of job of the individual. Here again, encourage and recognise improved performance.

There will be occasions when you disagree with your boss. In such cases, express your views to him and support your arguments with facts and figures. Do not just disagree, but offer new suggestions and solutions. But if you are over-ruled, put aside your personal views and manage the situation in a positive way.

3. MANAGING QUALITY

As a manager, you are responsible for the quality of service and work in your area of operation To manage quality, you and your staff should have a clear idea of the standards required. Once, the eppropriate quality standards are decided, plan how you and your staff are going to deliver the service and work to meet the required standards and the managers should see that the standards are achieved all the time.

4. USE OF COMPUTERS

No managers can afford to be without Computers. Computers can benefit the Engineers in their design and give guidence to them in the role as managers. It can do more routine works, thereby, making available, valuable time for creative thinking. In addition to this, it can be used for compiling technical project reports, preparation of contract documents and taking any number of copies, etc, through word processor.

CONCLUSION

Today, the requirements of institutions have become so complexed, complicated and wide that itis not just sufficient with what you have studied in the curriculam in a particular branch of Engineering. So to say, it is not sufficient being a Civil Engineer without some knowledge in Environmental, Electrical and Mechanical Engineering This is all the more true in the case of Civil Engineers working in the various Water Authorities. Inspite of all these, if performance is to be improved effectively and efficiently, there will have to be a set of new generation of young and dedicated Engineers in the system, taking up the new role as middle order "Managers".

With Engineers coming up successfully in their managerial role, they can ultimately take up the top ranks of Management of the Authorities and bulid up policies and formulate long range plans that will lead to a better Nation.

Extensive Coverage Through Partial Water Supply Schemes in Haryana

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On the carving of the Haryana State, out of combined Punjab, on 1st November, 1966, it inherited such geographical features which though were plan but had no adequate sweet underground water in most of its area In its southern districts not only the ground water is brackish but is very deep and the yield of the water bearing acquifers is very low and undependable The canal system covers major part of this area and serves as a raw water source for constructing water supply schemes in rural and urban areas. The State has a small portion of hilly area in its North which too is dry and does not have perennial rivers worth the name. All these factors complicated the problem of providing safe drinking water supply to its people living in the country side and the alternatives available were expansive. Out of 6745 inhabited villages only 170 villages were covered with water supply at the time of inception of the State and the task to cover remaining villages in a definite time frame was huge and challenging in terms of its financing and technical implications. However, the planners of the state determinedly started the work of providing drinking water supply in rural area and the villages were divided in two groups :–

(i)	Problem villages	5686
(ii)	Non problem villages	1059

The first priority naturally went in favour of the problemvillages where the water was either very deep or was highly brackish and in many cases it was both.

By November, 1989, 5687 villages (5367 problem and 320 non problem) had been provided with drinking water supply leaving 1058 villages (319 problem 739 non problem) still to be covered. The Government took note of the difficulties experienced by the population of these villages and decided to give top priority to cover remaining 1058 villages by December, 1990, according to which the annual plan of the State was formulated where the highest priority was given to providing adequate resources to achieve this target.

The work before the state and its Public Health Engineering Department was challenging, as in the earlier days about 400 villages were being commissioned in a year, whereas, now more than 2½ times that number was expected to be covered with piped drinking water supply schemes. Of these, 948 villages are to be covered with tubewell water, whereas 110 villages will be covered by constructing filtration units based on canal water.

The resources of the State and the assistance from the Government of India has always been inadequate and the ambition of the state to provide a minimum quantity of safe drinking water to its rural population being prime, a via media was worked out and the execution of the schemes has accordingly been done. In the subsequent paras we will discuss the details which were gone into in making such a decision As is clearly understood, in small drinking water supply schemes, the tubewell as source is most economical and is also easier for its day to day maintenance in the subsequent years whereas the filtration scheme based on canal water is a necessity where the ground water is either brackish or the yield is not dependable but is very expensive in initial cost as well as in maintenance.

A tubewell based water supply scheme, in principle, cosists of construction of a tubewell, pump chamber, chowkidar hut, OHSR, boundary and laying of distribution system. The function of the OHSR is mainly to properly regulate the water supply to its consumers at specified time and at uniform pressure If this component for some time is not constructed, the beneficiary will still have enough water from the tubewell under required pressure but the rate of flow of water will vary as per its operation and requirement as the facility of balancing the flow of water from the source to the consumer is missing. A study in the field however

indicated that if the construction of OHSR is deferred for some time, it did not affect the system so adversely as to warrant its immediate induction in the system Rather at places where level variation in the ground of the villages is higher the high pressure by the pump and extra flow helps in taking care of this eventuality. The other components such as construction of tubewell, pump chamber, chowkidar hut and laying of distribution line is a necessity and had to be constructed in the first instance before a scheme is declared as commissioned. By deferring the construction of OHSR in the system the immediate relief on the financial resources was to the tune of about 40% and was appreciable to be utilized for covering more number of villages in the limited annual resource allocations.

Similarly, a water supply scheme based on canal water mainly consists of inlet channel, S & S tanks, high level tanks, filter beds, clear water tanks, pumping machinery, pump chamber, OHSR and distribution system The norms for preparing design or such schemes has been for projection of population for next 30 years which anticipate an increase of 50% on the present population Thus, any water supply which is completed today, for the present population, will have a surplus capacity of about 50% in its source Appreciating this inherent component in the design of water supply, it was decided that, to start with, only 50% capacity of S & S tank be constructed, whereas the filter will also be constructed for about 66% of the designed capacity . The construction of the OHSR was deferred till adequate resources are available after the major problem of the State is tackled With this arrangement it was possible to provide per capita water supply of about 25 to 30 litres per head per day against the required norm of 40 litres per head per day. There have been some programmes which have been executed with the assistance of the Government of India and the World Bank authorities where such relaxation has not been permitted and there each scheme has been constructed for the ultimate design of the system. The number of such schemes is not many but is appreciable.

This relaxation of constructing part structures in the field has been exercised under the Minimum Needs Programme sponsored by the State only. The yearwise coverage of villages under MNP, WBP, and ARWSP is given below :-

Year	coverage			
	MNP	ARP	WBP	TOTAL
Upto 31-10-1966	170	–	–	170
1-11-66 to 31 3 77	701	–	–	701
1977-78	70	55	–	125
1978-79	60	55	15	130
1979-80	92	65	33	190
1980 81	128	82	50	260
1981 82	192	82	51	325
1982–83	267	70	31	368
1983 84	305	82	70	457
1984 85	377	241	202	820
1985 86	350	182	88	620
1986 87	294	178	38	510
1987 88	265	135	16	416
1988-89	210	141	12	363
1989 90	323	137	9	469
TOTAL	3804	1505	615	5924
BALANCE				821

This principle has been applied to the remaining 821 villages to be covered in the current financial year i e. 1990 91. By the end of this financial year the State will have the distinction of providing water supply to all its census villages Effort has been made to cover the major establishments called dhanis which have come up around these villages as well.

Once the work of providing minimum quantity of potable water to its villagers is complete, the work of augmentation of the water source and strengthening of the distribution system will be taken in hand in the next Five Year Plan. This will involve about 2800 villages where the present per capita water supply is around 20 to 30 litres per head per day. This is likely to cost about Rs. 66 crores at the current price level.

Another interesting development in the rural areas of the state has been noticed where the demand for private water connections has increased tremendously. This apparently is a direct reflection of the improvement in the living standards of the rural people in the state as well as the liking of the retired civil and military personnel in their respective villages.

The water supply through the common stand posts, though is the only alternative with the present available resources, but in general it has been noticed that wastage of water is huge and no measure, whatsoever, planned technically or administratively is adequate to prevent it. The reality of the situation with respect to this aspect has been accepted and it has been thought by the planners and policy makers that the only alternative to it will be to encourage private water connections so that at suitable time, the public stand posts which will become redundant are phased out and the precious water is preserved. This will require augmentation of water source and strengthening of distribution system to cater atleast 70 litres per head per day and in the next Five year plan a start is proposed to be made in this direction. Such villages which will be picked up for this experiment will also be provided with paved streets with properly designed drainage arrangements. This will be essential to avoid insanitary conditions in the villages which are likely to be caused due to the waste water from the houses and stand posts.

The maintenance of rural water supply system by the Public Health Engineering Department has become an important opening for adjusting the rural youth as Operators, Helpers, Electricians etc. and at present the panchayats which had at one time been maintaining their own water supply system have succeeded in handing over their units to the department with the consent of the Government Thus, the peoples participation in maintaining such units could not have any break through even when the department considered that it would have been more easier and may have also been economical to maintain such schemes if the panchayats could have been ready to take these over. Before the public representatives in the villages are really called upon to take the responsibility of maintaining their system it will require lot of pursuance, education and incentives almost matching the cost of maintenance now being incurred by the department. In the State, at one time, the water supply schemes were handed over to the municipalities in various towns for their maintenance but unfortunately after a lapse of few years these schemes had to be taken over by the department again as the municipalities virtually collapsed in serving its population through these water supply schemes. At present very few municipalities in the State are running their own water supply schemes which are reasonably big and are in a position to afford services of a municipal engineer in their set up but are itching for an opportunity to shed this liability

This sxperiment in towns is a drag in pushing the maintenance of water supply to panchayats, with added fear that the assets so created at a very high cost may be damaged, deteriorated or may be allowed to collapse altogether in due course of time. The social organisations in the State of Haryana are virtually missing and there is hardly any association worth the name who can take such work with the desired zeal.

Economic condition of the rural population in general is not such that it can afford to pay direct taxes towards maintenance of water supply systems but the farmer in general does not mind paying a small amount as tax on the food grains which he sells in the market The recovery of cost of maintenance has ultimately to become a part of this tax and will be in a position to meet the cost without difficulty

Once, eighty percent population of the State, which lives in 6745 villages in the country side, tastes the basic civic amenity like water, is likely to become more demanding in due course of time. This will retain enough pressure on the State Administration to provide more funds in years to come to meet with their soaring inspirations.

Thus, once we have stated that all villages in the State are covered with safe drinking water supply schemes, will virtually mean the opening of a new era for developing these villages for better living in future.

□

Store & Procurement of Materials

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STORE:

The word stock & store are used somewhat loosely but such a lack of discrimination is not of serious consequence. "Store' generally relate to goods on hand in the form of material awaiting conversion by some process or other to another form, whilst 'Stock' implies converted stores of manufactured goods generally.

By an effective system of stock and stores control the following in addition to other advantages may be gained:-

1) Prevention of over & under stocking.
2) Prevention of accumulation of obsolete materials.
3) Economy in floor space, labour & clerical service.
4) Reduction in overhead expenses.
5) Reduction in blockage of money.
6) Improvement in service.

Broad objectives and requirement of material management scheme are:

1) Have stock available when and where needed.
2) Utilise available storage space, but prevent stock levels from exceeding space availability.
3) Meet a high percentage of demands without creating excess stock levels
4) Maintain adequate accountability of inventory assets.
5) Keep all expenses within budget authorisations.
6) Decide what items to stock & what items to procure on demand.
7) Provide on an item by item basis, reorder points and order quantities such that the aggregate result will meet the above objectives.

A lax policy of stock control can lead to heavy losses Excess buying and over stocking lead to high carrying charges, high rate obsolescence, deterioration and pilferage, and an excess of tied up capital. Material shortage on the other hand may idle men & machine, disrupt schedule of projects.

An effective material management is needed for

1) Ordering of goods in economic quantities.
2) Standardization of materials and parts in order to reduce variety and number of items in stock.
3) Preventing excessive stocking of non-essential goods.
4) Reducing losses due to inadequate inspection, material damage, deterioration, obsolescence, waste and theft etc.
5) Providing an accurate base for cost account and financial accounting.

Material managements in simplified terms means steps taken to ensure that right material, in right quantity and of right quality is made available at right place at the right time. The important basic concept of material management are discussed below:-

1) INVENTORY COST: It consists of carrying cost and ordering cost.

a) CARRYING COST: It includes interest, obsolescence, deterioration, depreciation and storage handling and accounting cost.

b) ORDERING COST: This cover the cost of gathering inventory information, paper works, placing tenders, evaluation of offers, writing the orders and receiving and inspecting the consignment on arrival.

2) LEAD TIME: The time period between the point of raising of an indent by the store and the point of receiving the materials by them is called lead time. It has an important bearing with inventory levels. Normally the lead time is quite high in the departmental purchases due to cumbersome process required for placing orders.

3) STOCK OUT:

When a particular item is not in stock when required we say there is a stock out on that item. Stock out may result in break down of machine and equipment of shut down of a service, which could be very costly and uneconomical. Thus understocking and overstocking both are undesirable and striking a balance between the two is infact the central issue of inventory management. It is always advisable to have small percentage of stock out and maintain low inventory levels.

4) INVENTORY TURNOVER: it is defined as the ratio of the value of materials consumed to the average investment in inventories for the same period.

$$\text{Inventory Turn over:-} \quad \frac{\text{Value of material consumed}}{\text{Value of average inventory.}}$$

Inventory turn over is a very useful index of inventory control. Higher the index, lower the inventory level and lower the cost of maintaining the inventory. The top management can keep itself informed of the broad situation through the use of such an index.

5) CODIFICATION: In order to introduce scientific planning in the stores, all stock items should be identified and listed by Number by classifying parts according to their permanent characteristics. Similar parts can be grouped together and unnecessary or obsolete items can be eliminated. Identification number also help the store room force to put similar materials together. A rationalised codification system improves efficiency and reduces paper work.

In general, a numerical code is preferable to alphabetic code since it is amenable to easy processing and analysis. A typical example can be of six digit code in which the first two digit denote class, next two digits denotes a serial number items under each sub class.

6) INVENTORY RECORDS:

An inventory record is essential for keeping a running account of incoming materials, out going materials and balance on hand. A proper recording system facilitates instant checking of quantity on hand and activity of particular item.

To have a complete record of the activity of an item management should arrange for the following information to be on inventory record card.

i) The item number and name.
ii) The location in the stock room.
iii) The normal ordering point and ordering quantities.
iv) Receiving information-date, purchase, order number, quantity received and unit cost.
v) Reservation information date, quantity reserved, reasons.
vi) Issued information date, requisition number, quantity and unit cost.
vii) Balance quantity and unit cost.

7) MANAGEMENT REPORTING:

In order to exercise proper control of inventories, management should get periodic reports. The Number and format of reports may vary according to the needs, the following are the basic reports.

i) Daily/weekly stock status reports of a item.
ii) Monthly reports of inventory holdings for important items.

The management must lay down targets of inventory holdings, evaluate determine variance between target and actuals and take corrective measures.

iii) Monthly reports on nature of stock out, losses due to stock out and action taken.
iv) Monthly list of non movable items.

8) CENTRALISATION VS DECENTRALISATION OF STORES:

There is no cut and dry principle for deciding centralisation or decentralization of stores. It depends upon the volume involved, physical distances, storage space available, nature of materials and nature of organisation. Central Store room require less personnel and can place bulk orders where-as decentralised stores require more personnel, reduce delay and cost less in handling of materials.

a) INVENTORY STORAGE AND HANDLING:

Storage areas should be located for minimum transportation, they should be laid out for easy access to materials. The materials most frequently used should occupy the most accessible location.

Normally materials have to be stored in such a way that the other items are used first. Stock rooms of any size should have location designated such as Aisle No. Row No. Bin No. Rock No. etc.

The stock room should be kept free from dirt, material should have the stock room in as good condition as they are received. Obsolete items and any item which has become damaged in storage should be written off as soon as they become obsolete.

10) SUPERVISION OF STORES:

Following steps are necessary for effective supervision of stores:-

i) No material should be issued without proper store requisition.

ii) The store room should be properly locked and only authorised persons should be allowed to handle the stores receipts and issues.

iii) Physical inventory should be used to verify the balances on books.

11) PROCUREMENT OF MATERIAL:

Procurement is a general term which includes purchasing and related activities. Thus procurement activities are:-

1) Selection of vendors.

2) Establishing price and services.

3) Preparation of orders and supply contract performance.

4) Arrangement for schedule deliveries and contract performance.

5) Proper records and relations with supplies.

6) Maintenance of records and disposal of surplus and scrap materials.

Prime activity also includes effective communication with user and other source department as also with the supplier. Frequently problems require direct communication and discussion between the user and the supplier for technical reasons. Thus procurement activity falls into four major areas.

1) Sourceing

2) Procurement

3) Follow up

4) Expediting and other auxillary materials services. In departmental procurement of materials the following are the agencies from where the materials (stores) are normally procured:-

1) D. G. S. D. NEW DELHI

This is a centralised organisation of Government of India and it enter into contract with most items after inviting tenders from the various manufacturers. This organisation is playing a very vital role in procuring stores for the Govt. of India where it is mandatory to purchase stores from this agency, where as it is not obligatory for State Govt./Public Sector to do so. However, on specific demand this organisation do arrange procurement for State Govt. and other user deptt. at very nominal service charges. This organisation have an established time tested system of procurement mostly through registered and tried sources. This organisation finalises the rate contracts so that the user department can avail the facility of minimum inventory and ready list of suppliers with following additional advantages:-

1) Minimum lead time: After Ist tender the procurement process is cyclic with no break in the rate contract so there is no lead time.

2) The choice of placement of supply order rests with the indentor.

3) There is lot of flexibility associated with the operation of supply orders as the indentor can split up his requirements on monthly, quarterly or any time bound schedule when the need arises.

4) Better user control i.e. the indentor will have the choice to place order on firms with better performance.

5) Watching of load performance etc. directly by the indentor obviates the intervention of D.G.S. & D. for all contractual obligation.

6) Better direct Monitoring by the Indentor. The indentor is apprised of the possibility of delay in supplies directly by the supplier immediately on receipt of supply order and can take corrective measure promptly.

7) Economy of purchase can be ensured by D.G.S. D. by entering into parallel rate contracts and stable price over a period and operation control will be with the indentor which is definitely a better process instead of the need to undertake tendering processes in the system encountered in adhoc purchases.

8) The trade claims it is Hall Mark of prestige to be on D.G.S. & D. Rate Contract.

9) The advantages are so obvious that the D.G.S. & D's procurement of approx. 75% by value is through rate contracts.

10) Large Number of Rate Contracts in respect of C. I. S & S Pipe, C. I. D. / F Pipe, C. I. S & S specials, C.I.D/F specials, E.R.W. Pipes, M.S. Pipes. G.I. Pipes, P.V.C. Pipes, H.D.P.E. Pipes, A.C. pressure Pipes Sluice valves & Hand Pumps etc. which are most commonly required for completion of R. W. S. S.

In case some items of frequent use are identified, this organisation can enter Rate contract for these items as well.

2. CONTROLLER OF STORE OF STATE:

This organisation also enters into rate contracts for items to be used by the Department. But it takes a fairly long time in finalising of rate contract. The rate contracts entered into are not broad based and only few firms are brought on rate contract which are not in a position to meet the requirement of the Department. Due to the Policy of State Govt. to give 15% price preference on product of State owned small scale industry gives rise to price of material. Even the inspection wing of Controller of Stores Department is not very capable. Due to the long validity of rate contract some time the accepted rates becomes unviable due to price rise of the commodities & there is no price increase clause.

It is obligatory on the part of indentor to exhaust the contractual limit of the contract before going in for any purchase against D. G. S. D. rate contract even though it may be little cheaper.

In case of any failure in supply due to some reasons by the suppliers no fruitful action can be taken by the indentor except to report the matter to Controller of Stores which brings no results.

3) OPEN TENDERS:

Tenders are invited for the items not borne on rate contract giving due notice in press media and after proper evaluation of its price, specification, previous performance the firm is selected to execute the order but special clauses e.g.

a) Escalation clause.

b) Guarantee against decline in price.

c) Cancellation clauses.

must be taken care of.

After a judicious decision is taken to purchase the material from any agency a supply order is placed with the firm against agreed contract. The supply order must contain the following:-

1) Exact detailed technical description of store.

2) Conditions of its delivery to consignee.

3) Payment clauses on receipt of material.

4) Prior inspection of the expert regarding quality of stores.

5) Literature for its use alongwith any special instructions requiring attention of the user.

6) Guarantee-Warranty clause.

7) Time schedule for despatch of stores.

8) Acceptance within 2 weeks time from the supplier in respect of stipulation of the supply order. □

Level of Water Tariff Burden in Water Supply Schemes - Few Thoughts

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There is not much disagreement in the fact that supply of potable water is a human need. There is considerable variation in the concept of the subject by different individuals and disciplines depending upon their background.

A present day Engineer's perspective will be a system consisting of intake works, treatment plant, reservoirs, distribution pipe net works, water taps which deliver water to the consumer. An Economist's perspective will be the allocation of resources to implement a project and possibly improve the distribution system. A Nutritionist's and a Doctor's perspective will be the quality and the reliability with respect to it of the water supplied in order to reduce the incidence of diseases and infections. Improvements in the quality of the effluent after treating the waste water will be the perspective of the Environmental Scientist. Of course the above all are right one way or the other. They merely indicate that water supply and sanitation have a number of different aspects. But then, it is important that all involved in water supply and sanitation systems should be aware of all the various aspects of the same.

To some extent the technical components of water supply, sanitation and sewerage systems design and implementation are easier as the required criteria have been established fairly well due to lots of research and experience. The difficult part is establishing pricing policies. By its very nature, pricing policies bring the water supply sector squarely into the realm of politics of economics WHO PAYS AND WHO BENEFITS? This aspect of water supply planning can be examined in two view points. First at 'USERS' level and second at 'PROJECT' level.

a) USERS CHARGES: It is always argued that no charges whatsoever shall be levied for water supply. There are two main arguments against this view. First–food, clothing, and shelter are also very important needs, but they have to be paid for. So why should water be different? And secondly the absence of water charges would lead to the better off gaining most, as they tend to consume larger quantities of water and therefore receive large share of subsidies. This is clearly inequitable. More over, the payment for water will encourage economy in its use, raise revenue for further investments of the system.

A sense of justice and common-sense would suggest that the less-well off community should pay a smaller portion of their income than the betteroff. By charging the rich more per litre than the poor, the former subsidises the latter. For such subsidies to take place one of the two undermentioned conditions must be met.

1) Low-Income Consumers must be identified as a separate category and charged less.
2) The higher the consumption level a higher rate may be charged.

b) THE PROJECT LEVEL:

How are the water supply and sanitation projects be funded? In developed economics, statutory

Water Authorities raise sufficient revenues to cover not only administration and maintenance cost, but investment cost as well. In systems where 100% of supply is through consumer connections, individual meters are established and/or different methods of collection of payments which are acceptable are arranged. But what about developing countries where the situation is very different? Funds for investment are available from revenue, loans or grants and mix of all three sources. Loans can be from the public or the private sector, from domestic or international sources, on soft or hard terms. Water supply is a very "VISIBLE" sector and will thus be major area of interest to decision-makers and politicians in terms of:-

1. relative share of the annual budget.
2. where any new investments are made
3. where existing systems are maintained or improved.
4. the proportion spent or new investment as against the maintenance and operational and administrative expenditure.
5. whether any charges or innovations in pricing policy should be introduced.

All these points are sort of political topics, which will have major impact on who pays and who benefits. The politicians are likely to have different ideas from those of economists and Engineers. In these situations it is vital that the full implications of the various options are drawn out and explained.

For example, suppose water tariff schedule had not been revised for years, inflation would have reduced the real level of payments resulting in inadequate funding for both maintenance and investment. Raising the charges are likely to cause considerable protest especially from economists and politicians. There is no easy solution to it. Ideally, charges should be raised from time to time with inflation variations to prevent sudden jumps.

The project designers, Engineers, Economists exert influence on the annual allocation for funds from the national budget process. Obviously, design standards influence costs-designing for 20 years is more expensive than that for 10 years. At one level, a cheaper system may have more chances of attracting funds than an expensive one, but it is usually more maintenance intensive. But then the question will be whether those maintenance funds be available ?

Having examined the two view points at the Users level and at Project level, let us go into a case study on Tariff Burden in selected Cities.

TARIFF BURDEN IN SELECTED CITIES - CASE STUDY

In a large City, consumer connections taken from the public water supply system has been lagging and water authorities have identified high connection fee as a main obstacle for this. Since the required cash outlay exceeds 20 to 25% of total annual income for the low income groups, it is no wonder that low income segments largely are not connected to the system. More over, stand pipe supplies and ground water availability provide alternatives to the unconnected households. Thus the management would desire to increase the number of conections by financing connection fees and would like to assess what the maximum combined burden of connection fees and consumption charges should be.

Now, let us examine the details of survey by World Bank development Economics Department on the Tariff Burden in selected Cities all over the world. The details furnished below are nothing but the estimated monthly water charges as percentage of estimated monthly income.

	Lowest 20%	Second 20%	Third 20%	Fourth 20%	Upper 20%
Addis Ababa	9	8	8	6	2
Ahmedabad	4	4	11	12	27
Bogota	1	1	1	1	2
Bangkok	1	1	2	2	1
Cartagena	1	1	1	1	1
Kingston	2	3	6	4	1
Lima	5	2	1	1	1
Manila	9	2	2	2	1
Mexico City	Less than 1% at all income level.				
Nairobi	7	6	6	4	2
Sao Paulo	5	2	3	3	1
Seoul City	Less than 1% at all income level.				

It can be seen that some of the survey data have underestimated income level or underestimated water related charges since implied share of income that would go for water consumption seem very high. It appears that connection and consumption charges could well be in the order of 5% of income without causing undue hardship. Indicative percentage of 5% is also supported by data from a household expenditure survey conducted in the city itself. The share of income expended on tobacco and alcohol is in the order of 5 to 8% as could be noted from the details furnished below:

Less than 3000	- 5
3000-6000	- 8
6000-9000	- 8
9000-12000	- 8
12000-15000	- 8

It does not seem unreasonable to set apart 5% of their gross income on combined connection and consumption charges. To facilitate billings and collections such charges would have to be supported by propaganda to explain why these charges are necessary.

In conclusion, it is worth emphasising the fairly obvious point that better planning and design will influence the possibilities of attracting funds into the Sector. Water Supply officials should cultivate and maintain good relationships with planning and budgetting departments. Emphasise the productivity implications of investments, the basic human needs angle, the environmental aspects as Water Supply is so much more than a system of pipes, pumps and Tanks. The benefits out of water supply schemes is not directly quantitative and is a must on the health point of view. Shall we not pay for the benefits? Shall we not help the organisation, running a water supply scheme by paying for the benefits of better service, improvements of the system? Does it seem unreasonable to set apart 4 to 5% of one's income to pay for the benefits out of water supply facilities to help the Water Authorities and to be helped by the Authorities? □

INDIAN POINT OF VIEW

No one talks more about his ancient heritage and culture than an Indian. Indeed, with the present in complete mess and the future frightening, what else can we talk about. There is a craze about cultural festivals. These cultural festivals are escapism at a national level and on a gigantic scale. We simply boast about the past, don't work in the present and are unprepared for the future.

We observe Rahukalam to the minute but have no guilt in not keeping an appointment. We will spend hours learning music but will shirk work.

And we have very little time, what we will be in 2000 AD will depend on what we do now. Let us not waste time on the past and the irrelevant; the present is all we have got.

Basic Concept of Pollution-Control Towards the Protection of Natural Water Resources

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Madras

INTRODUCTION

Protection of natural water resources is manifold and protection by pollution prevention is the major issue presently. In India water resources are many but their protection is few. Harnessing river water by the construction of dams has been undertaken very efficiently but the promised river flow down-stream the dam has not been maintained for a variety of reasons. This has resulted in the drying up of river beds but for storm water flow during monsoon and glacier fed rivers. However, during successful monsoon years, the rivers were as expected and their protection does apply. While the above statement describes the existing pattern of occurences, water pollution has threatened the water quality of these resources and has even left some of these rivers and lakes unusable even for recreation purposes as it happened to Dal lake in Kashmir. Thus water pollution is the major problem from the viewpoint of protection of waters. Certain basic concept is necessary in order to effectively implement the pollution control strategy.

PRESENT STATUS OF WATER QUALITY

The Indian scenario of water pollution status has been rather alarming in 1970 owing to rapid industrialisation and urbanisation since the advent of independence. The water resources such as rivers, lakes, reservoirs and sea were thrusted with untreated sewage and other wastewaters. Finally a beginning towards a solution was made by having the legislation since 1974 and formation of statutory pollution control boards at State and central level.

In North India, industrialisation has been undertaken along the course of river in several instances. For example, river Patalganga in Maharashtra supplies water to the industries and receives wastewater for disposal. Sample of this river water indicated level of pollutant (BOD) as high as 150 mg/1. The Ganges, its tributaries, etc. also suffer from sewage and industrial waste pollution (BOD 20 mg/1). The River Cauvery in South India is a parallel example of polluted condition. While the water quality criteria for river for using as public water supply source is only 4 mg/1 of BOD level as per IS 2296-1982, the forecast of the pollution problem is exhorbitant.

BASIC CONCEPT OF POLLUTION CONTROL RELATED TO SURFACE WATER:-

Wastewater of both domestic and industrial origins predominantly needs disposal. Four kinds of disposal measures available in India are sea, sewer, land and river. Of late, the land disposal is forbidden by Pollution Control Boards in some States of India and this further aggravates the available surface waters. Thanks to the pollution control strategy in India, the discharge standard levels of pollution for marine waters and river are BOD 160 mg/ 1 and 20-30 mg/ 1 respectively. The initial BOD level of wastes range from 250 mg/ 1 for sewage to as high as 1000-5000 mg/ 1 as in the case of milk waste, starch waste, etc. In the solitary case of distillery waste, BOD level goes upto 40,000 mg/ 1. Thus the raw BOD levels and the desired treated effluent BOD levels distinguish themselves quantitatively and this aspect underlines the need for raw waste treatment before disposal.

Thanks to the efforts taken by some of the leading research institutes like NEERI and other University Departments, treatment flowsheets are available almost for all types of industrial effluents like pulp and paper, chemicals, starch, milk, distillery, sugar, textiles, etc. In addition, toxic elements like chromium in leather industry, arsenic in fertilizer, cyanide, nickel etc. in plating factory, etc. pose problem and warrant treatment techniques. These techniques are also available. For example, CN may be treated by alkaline chlorination, chromium by lime precipitation at pH 9. arsenic by evaporation, etc.

Therefore, the basic concept of pollution control emerges that the waste of high BOD will be treated by suitable techniques and disposed off into one of the four disposal measures namely, marine waters, river, sewer and land. The extent of treatment will depend upon the desired treated effluent discharge standard stipulated for each of the disposal measures.

As an extension of this concept for the betterment of water pollution control, the special techniques for the dispersal of treated effluent into sea/river may be employed for effective dilution and assimilation of pollutants. The special techniques include marine outfall diffuser.

BASIC CONSIDERATIONS AND METHODS OF TREATMENT:

Basic consideration includes inplant survey within the industry wherein the sources of pollution, its volume, sampling and analysis, characterisation, treatability, etc. will be identified.

The methods of treatment of BOD removal are both conventional and latest arrivals. The activated sludge process and trickling filter backed by experience can be effective upto 90% BOD removal. However, more effective efficiency is required in order to meet stringent pollution control standards and therefore, latest techniques include aerated lagoons and oxidation ditches (95-98% BOD removal). These processes are easy to construct and operate and dispense with pretreatment and therefore they are less costly and known as low cost treatment plants.

SUMMARY AND CONCLUSION:

Water sources in India are many and well harnessed by dam construction, etc. However, rapid industrialisation and urbanisation resulted in acute water pollution problems. From this point of view, protection of water sources by pollution prevention becomes important and imperative. For implementing these control measures, certain basic concept serves as best tool in order to achieve the desired end results.

While wastewater bearing high pollutants ultimately return and reach the water sources, protection measures are stipulated. The high BOD wastes include pulp and paper, textile, tannery, starch, fertiliser, etc. The effluent discharge standards stipulate 100 mg/1 of BOD and 20 mg/1 in respect of marine water and inland surface water. While raw water quality criteria stipulate 2-4 mg/1 of BOD to serve as public water supply source, this aspect should be kept in view for deploying special techniques.

Treatment techniques are now available for reduction of organic pollutant (BOD) upto 95-98% depending upon the extent of treatment desired in a particular situation. These techniques include aerated lagoons and oxidation ditches. Particularised treatments are also available for the removal of toxic pollutants like CN, Ni, Cr, As, etc.

Basic concept and basic considerations in the matter of pollution control works will enhance the performance of the pollution control strategy and yield a better environment. The protection of natural water resources is fulfilled in this act of pollution control □

ON WOMEN'S EDUCATION

Lack of education is root of all evil. Whatever a man loses by lack of education, a woman too does. Nay, she needs education the more, for, it is she who is the prime person bringing up children. She would be handicapped in this function by ignorance and the result would be the detament of a whole generation. Women's education, thus, is of paramount importance.

RECOMMENDATIONS

Recommendations of the Seminar on Financing and Management of Water Supply Schemes - Thiruvananthapuram -1990

1. The Seminar recommends that the Government of India should step up the outlay for urban water supply and sanitation sector in the eighth plan to achieve the water and sanitation decade targets.

2. The Seminar strongly urges that the State Governments must ensure that committed funds are made available according to schedule of requirements for the timely completion of the projects.

3. The Seminar recognises the fact that HUDCO has opened a separate window for funding of urban infrastructure specially for water supply and sanitation. The Seminar recommends that the assistance coupled with LIC funding and otherfunding agencies should be substantial enough to achieve the targets of thedecade programme. The StateGovernments should take full advant-age of this facility.

4. As the water supply projects are designed to cover the projected population which generally extends for a long period, the Seminar feels that a differential rate of capital and interest repayment increasing from a lower to higher level covering the entire repayment period without affecting the total cost of capital and interest investment should be considered. The moratorium period of loan should be 5 years or completion of scheme, whichever is earlie. In case of HUDCO funding, repayment period should be made similar to that of LIC.

5. Realistic water tariff should be fixed taking into account all the related costs.

6. There should be a centrally sponsored programme for urban water supply and sanitation where priority should be given to chronically drought prone and water shortage areas and projects which will increase the access of the poor to protected water supply.

7. Water supply should be treated at par with agriculture and all subsidies, such as those on duties, taxes and energy charges available for agriculture should be made applicable to water supply also.

8. National water policy formulated by Government of India in 1987 has to be implemented by all State Governments to ensure that there is no constraint in locating sources for drinking water supply.

9. Drinking water being a very valuable commodity, a serious effort has to be made to create adequate awareness amongst the consumers that the right price has to be paid for this commodity. Supply through service conn-

ections should be appropriately measured and accounted for. There is a need for promoting awareness among the beneficiaries through various media on coservation, cost and health benefits.

10. Involvement of local bodies in planning and development of water supply and sanitation schemes should be ensured.

11. The soft-ware on MIS and systems design provided by Government of India should be fully utilised by Water Supply Agencies and also there should be a periodical feed back. The MIS cells should be strengthened adequately for optimum utilisation.

12. A national level training Institute in the field of PH/Environmental Engineering is needed for promoting training programmes.

13. Water supply agencies should take full advantage of existing training programmes sponsored by Government of India and other agencies. There is a need to set up training institute at State level to train professionals and hands on training for semi professional personnel.

14. There is a need for comprehensive Operation & Maintenance planning right at the project formulation stage covering personnel, training, supplies and financing.

15. Every water supply agency should have preventive maintenance cells with emphasis on leakage control manned by trained personnel provided with necessary equipments. Leak detection surveys and repairs should be carried out on a regular basis.

16. As quality control and research and development play vital role in the management of water supply and sanitation systems, R&D cells should be set up in each water supply organisation at state level to conduct applied research studies and monitoring of quality control. The technical and Financial assistance provided by various funding agencies should be fully utilised by the State Governments.

17. For strict quality control every water works should have a well equipped laboratory manned by qualified staff to promote routine water quality surveillance.

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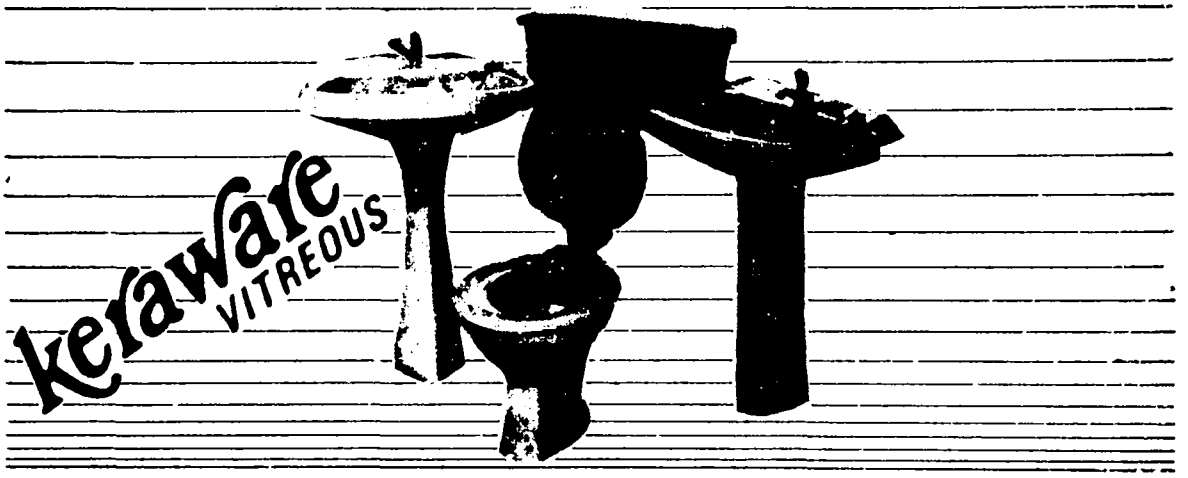

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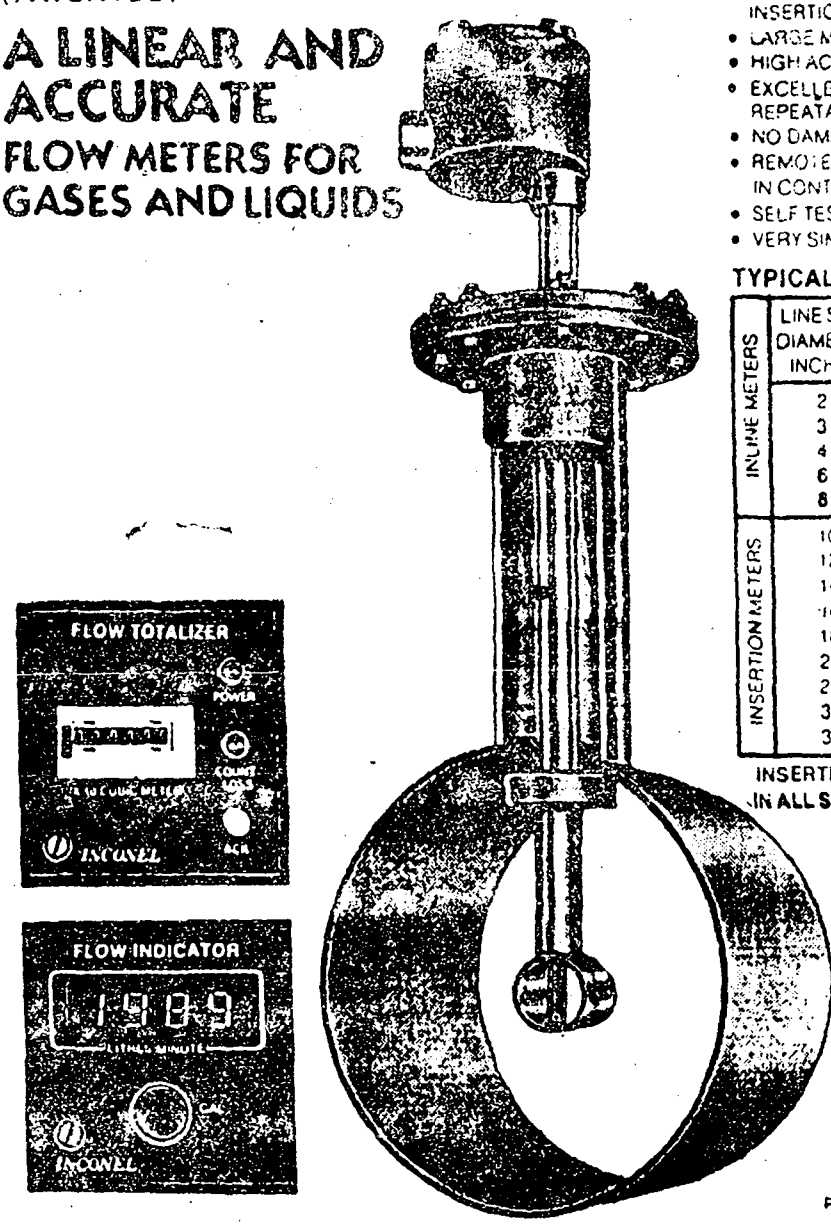

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